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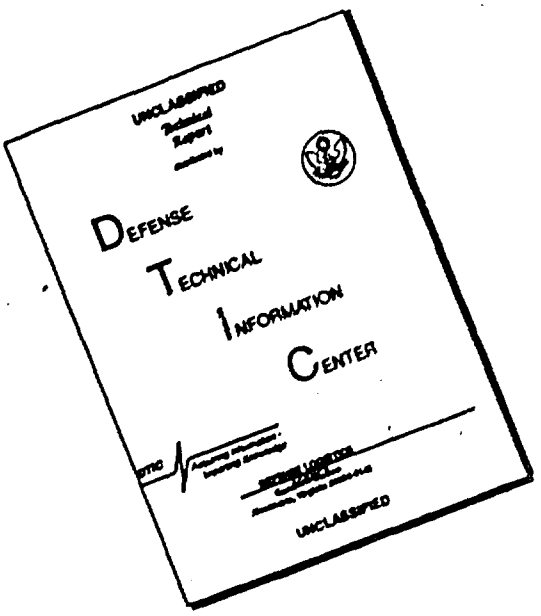

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VOL II

REPORT NO.
TDR-69 (2240-51)TR-2, VOL II

The Aerospace Corporation Computer Programs for the Solution of Multielement Chemical Equilibria

Volume II. Chemical Program Description

17 JULY 1963

Prepared by W. J. VALE
Computation and Data Processing Center

Prepared for COMMANDER BALLISTIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Norton Air Force Base, California

AEROSPACE CORPORATION
CONTRACT NO. AF 04(695)-69

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AEROSPACE CORPORATION
El Segundo, California

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FOREWORD

The first volume of The Aerospace Corporation Computer Programs for the Solution of Multi-element Chemical Equilibria was not designated Volume I. It was published on 28 June 1963, and the report number is identical to Volume II.

ABSTRACT

Work has been completed on a system of programs to compute complex chemical equilibria. These programs use a general numerical and analytical approach and accept a very flexible problem formulation. The computation capabilities of this system include rocket engine performance, flame composition and temperature determination, Mollier diagram production, and equilibria solution for any prescribed regime of pressure and temperature. Ionic species are considered where requested and when available.

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NOMENCLATURE

a	local velocity of sound, ft/sec
a_{ij}	number of atoms of ith element in jth chemical constituent
c_j	coefficient matrix of the jth product based on element columns (column matrix)
(C. M.)	coefficient matrix of major products based on element rows
$(C. M.)^{-1}$	(C. M.) inverted
C^*	velocity of rocket gas flow at the rocket throat, ft/sec
C_p	molar specific heat at constant pressure, cal/mole ^oK
E_j	equilibrium coefficient (row) matrix of jth product
g	gravitational constant (32. 174 ft/sec^2)
(H_m)	total relative molar enthalpy matrix of the major products (row matrix)
H_T^o	sum of sensible enthalpy and chemical energy, kcal/g
H_f	heat of formation of the data product kcal/mole
$(H_T^o)_j$	H_T^o for jth constituent, kcal/mole
IOPT	optimum (vacuum) impulse
M	molecular weight, g/mole
n	total number of moles
n_j	moles of jth constituent
P	pressure, lb/in^2
p_j	partial pressure of jth constituent, lb/in^2
$(\ln p_m)$	log partial pressure matrix of major products based on element rows (row matrix)
p_c	chamber pressure, lb/in^2

NOMENCLATURE (Continued)

p_e	exit pressure, lb/in^2
p_o	ambient pressure, lb/in^2
R	universal gas constant (consistent units)
s	gram entropy, cal/(g) ^oK
(S_m)	total molar entropy matrix of the major products (row matrix)
S_T^o	molar entropy at standard conditions, cal/mole ^oK
T	temperature, ^oK

I. INTRODUCTION

The computer programs described in this report form a logical system whose overall function is to compute chemical equilibria. The method used to solve the equation system is not unique in concept, but it is unique in both the manner of application and in the flexibility of approach.

Each program within the system produces a specific kind of solution. In this report, Rocket Performance, Mollier Diagram Producer, Flame Equilibrium Solver, and General Equilibrium Solver are discussed.

The system of programs is contained on a single library tape. All are written in the FORTRAN language, and all use the same data library tape.

II. OUTLINE OF PROGRAM SYSTEM

A. SYSTEM LOGICAL CONSTRUCTION

The program system consists of a series of FORTRAN main programs called chain links and a series of subroutines which may be associated with these main programs. Each link of the program chain communicates with its subroutine system and with other links through an area in the computer called COMMON. This region is used also for working storage whenever possible to minimize the memory storage not used for working instructions.

All input to the system is processed by the input link, which is always the first program written on the program library tape. This link reads and verifies the input data cards, searches the data library tape for the qualified system products, and produces the mass balance answer sheet. This link then calls the computation link requested by the user.

Individual links have been prepared such that the main program uses subroutines from a logical pool. A given subroutine is used in any of the links which require it. Improvement or alteration of any subroutine such that its capabilities are increased improves the capabilities of all the links which use it. The main program decides the type of matrix to be solved; and the subroutine system chooses the dependent variables, constructs the error matrix, solves it, and applies the proper corrections.

B. EQUATIONS USED

The basic system equations used are as follows. The derivations of the error equations are in Refs. 1, 4, and 5.

1. The Conservation of Atomic Types (Mass Balance)

$$\sigma_i = \sum_{J=1}^{\beta} a_{ij} n_j$$

where

$$\sigma_i = \sum_{J=1}^{\text{All products}} \text{(element i's coefficient in the jth product) * (number of moles of the jth product)}$$

2. Pressure Conservation

$$P = \sum_{J=1}^{\gamma} p_j$$

where γ stands for all gases. Condensed phases have zero partial pressure.

3. Conservation of (Static) Enthalpy

$$H = \sum_{J=1}^{\beta} \left(H_T^o\right)_j n_j$$

where $\left(H_T^o\right)_j$ equals total relative enthalpy per mole for jth product.

4. Conservation of Internal Energy

$$E = \sum_{J=1}^{\beta} \left(E_T^o\right)_j n_j$$

where $E_T^o = H_T^o - RT$.

5. Chemical Equilibrium

$$\ln K_j = \ln p_j - (C.M.^{-1})(C_j)(\ln p_m)$$

or

$$\ln K_j = \frac{\left(S_T^o\right)_j - (C.M.)^{-1}(C_j)(S_m)}{R} - \frac{\left(H_T^o\right)_j - (C.M.)^{-1}(C_j)(H_m)}{RT}$$

6. Conservation of Entropy

$$S = \frac{1}{A}\sum_{j=1}^{\beta}\left[n_j\left(S_T^o\right)_j - Rp_j \ln p_j\right]$$

where

$\left(S_T^o\right)_J$ = entropy per mole for jth product

A = MP

= (average gas mole weight) * (system pressure)

7. Acoustic Velocity

$$a^2 = \left(\frac{\delta P}{\delta \rho}\right)_s = \frac{RT\sum_{j=1}^{\beta} p_j\left[\frac{d(\ln p_j)}{d(\ln T)}\right]}{AM\left[\frac{d(\ln A)}{d(\ln T)} - 1\right]_s}$$

8. Conservation of System Energy

$$H_s = \frac{\sum_{j=1}^{\beta} \left(H_T^o\right)_j n_j}{A} + \frac{M^2 RT \sum_{j=1}^{\beta} p_j \left[\frac{d(\ln p_j)}{d(\ln T)}\right]_s}{2A^2 \left[\frac{d(\ln A)}{d(\ln T)} - 1\right]_s}$$

C. SYSTEM DATA STRUCTURE

Thermodynamic data from 0^o to 6000^oK are used and maintained in table form throughout the system. Particular values of C_p, H, and S are interpolated using adjacent table entries. The two problems resulting from this method of data reference are, first, the thermodynamic values obtained in areas where the curve's slope is rapidly changing and, second, the value between a solid and liquid phase of the same molecule. The first difficulty is resolved by increasing the number of tabulated values in the areas of great curvature, such as below 300^oK. The second is resolved by assuming that any species will crystallize in such a fashion that there will be super-cooled liquid droplets and super-heated crystals existing simultaneously.[1] Then, the numerical values of the thermodynamic variables may be obtained by linear interpolation across the crystallization discontinuity. This effectively averages the variables involved and allows all condensed species to be handled using a coherent, single, data list. There are no mathematical problems with multiple tables for the same species, but the programs updating the thermodynamic data tapes would be more complex, so this is not allowed.

The input chain produces a vector based on the elemental list of the particular problem. This vector is used to sort qualifying products from the data library. A qualifying product's data block is processed by updating the sensible enthalpies contained in the block to become relativised total

[1] The accompanying physical assumption is that physical contact between crystal and liquid does not exist.

enthalpies and by writing the updated data onto the data buffer tape. Further explanation of the enthalpy handling is perhaps required. The program must work with the total system energy as a positive number. In order to ensure this situation, all elements have an associated base enthalpy. These are algebraically added, depending on the elemental structure of the molecule, to form a base enthalpy for the molecule. (The list of element bases forms the first record on the data tape, see Table 1.) The heat of formation of the molecule, at 298.159°K, is added to this molecular base enthalpy to form the total enthalpy for the molecule at standard temperature. The sensible enthalpy (relative to 298.159°K) is stored on the data library tape in the individual data blocks as a function of temperature. Thus, at any temperature, an additional amount is added to form the total relative enthalpy.

The total relative enthalpy may be expressed algebraically as

$$H_j^T = \sum_{i=1}^{n} a_{ij} H_{base_i} + \Delta H_{f(\text{at } 298.159^\circ K)j} + \Delta H^T_{(298.159^\circ K)j}$$

Input data is treated in a similar manner with respect to the base enthalpies of the elemental components. The heat of formation from the ingredient formulation card is added to the molecular base enthalpy to form a total relative enthalpy per mole.

At present, the upper temperature in the tables is 6000°K. The program extrapolates linearly for values of C_p, H, and S for temperatures above this. There is no reason to limit temperature coverage to 6000°K, but all arrays must have identical temperature sequences since the temperature list is stored only once.

The data library and maintenance programs will be covered in detail in Volume III of this report.

Table 1

Elements Contained on the Data Tape and Their H_{base}

Element	H_{base}	Element	H_{base}
H	34.7204	S	108.3410
HE	0.0	CL	4.9985
LI	131.6341	AR	0.0
BE	131.2607	K	-20.0290
B	175.0770	CA	-44.5590
C	92.2136	TI	286.8570
N	1.8858	FE	98.1290
O	2.0554	NI	-99.9790
F	31.5318	BR	2.5000
NE	0.0	RB	-19.0290
NA	70.7260	ZR	389.6670
MG	253.5467	CD	23.7920
AL	233.6251	CS	-17.3490
SI	250.1876	PB	180.0310
P	5.5120	E	0.0

D. SYSTEM MAIN PROGRAM STRUCTURE

1. Input, Link 1

The input link (Fig. 1) has the dual function of reading the proper cards to initiate a problem and of altering the specification of the last computed problem so as to compute a new point. The input data cards are printed out before the data on them are used for computation or table searching. The library data blocks are buffered onto the secondary tape for faster data updating. Before selecting the requested computation chain link, the input chain searches a table for first guess values and makes them available for the computation link.

2. Rocket Performance, Link 2

The rocket performance link (Fig. 2) is separated into three logical divisions; the first two essentially prepare the foundation for the last. In the first part, the chamber temperature and composition are determined, the system is examined for the major products, and the entire system of the variables is

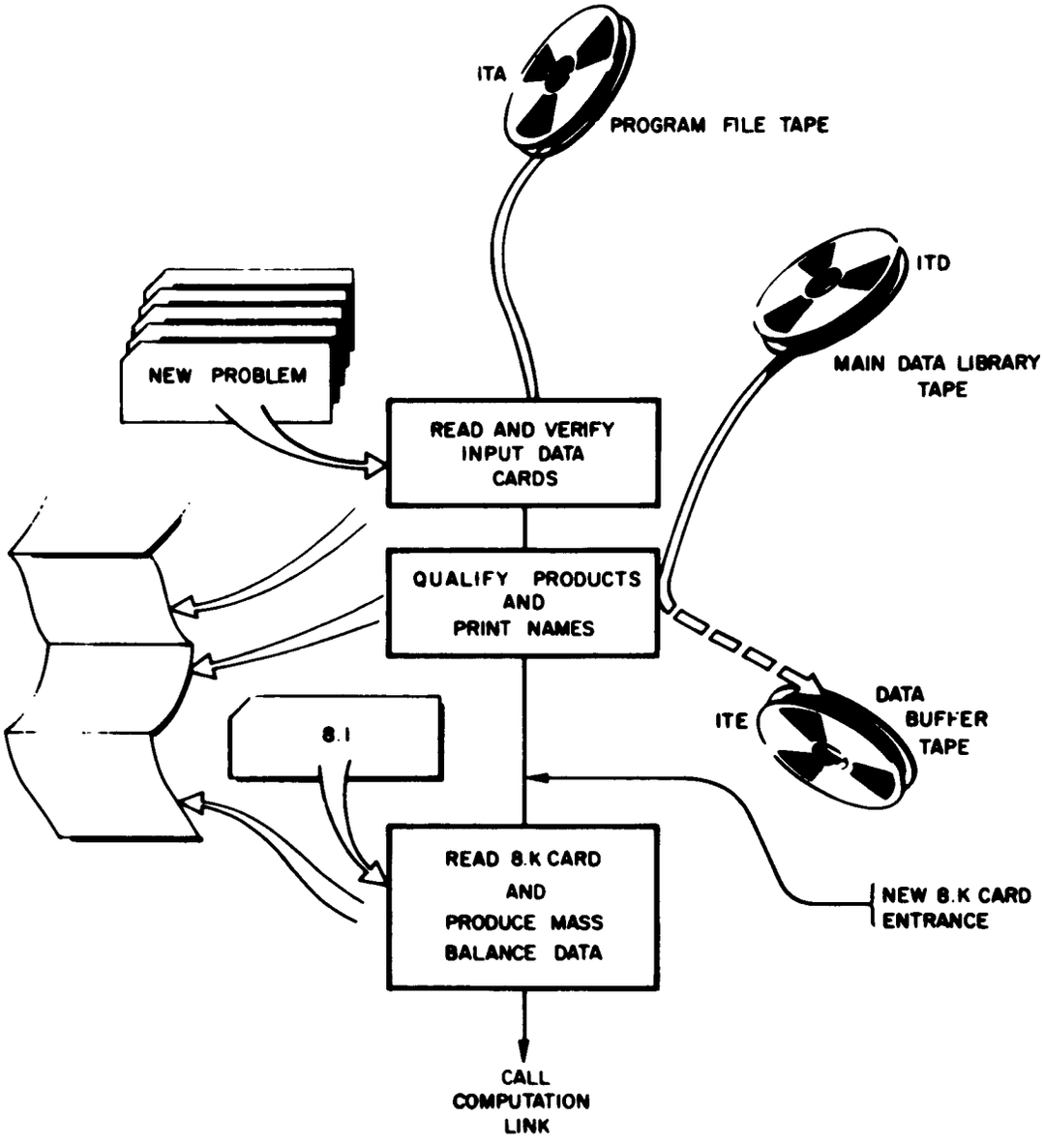

Fig. 1. Input Link

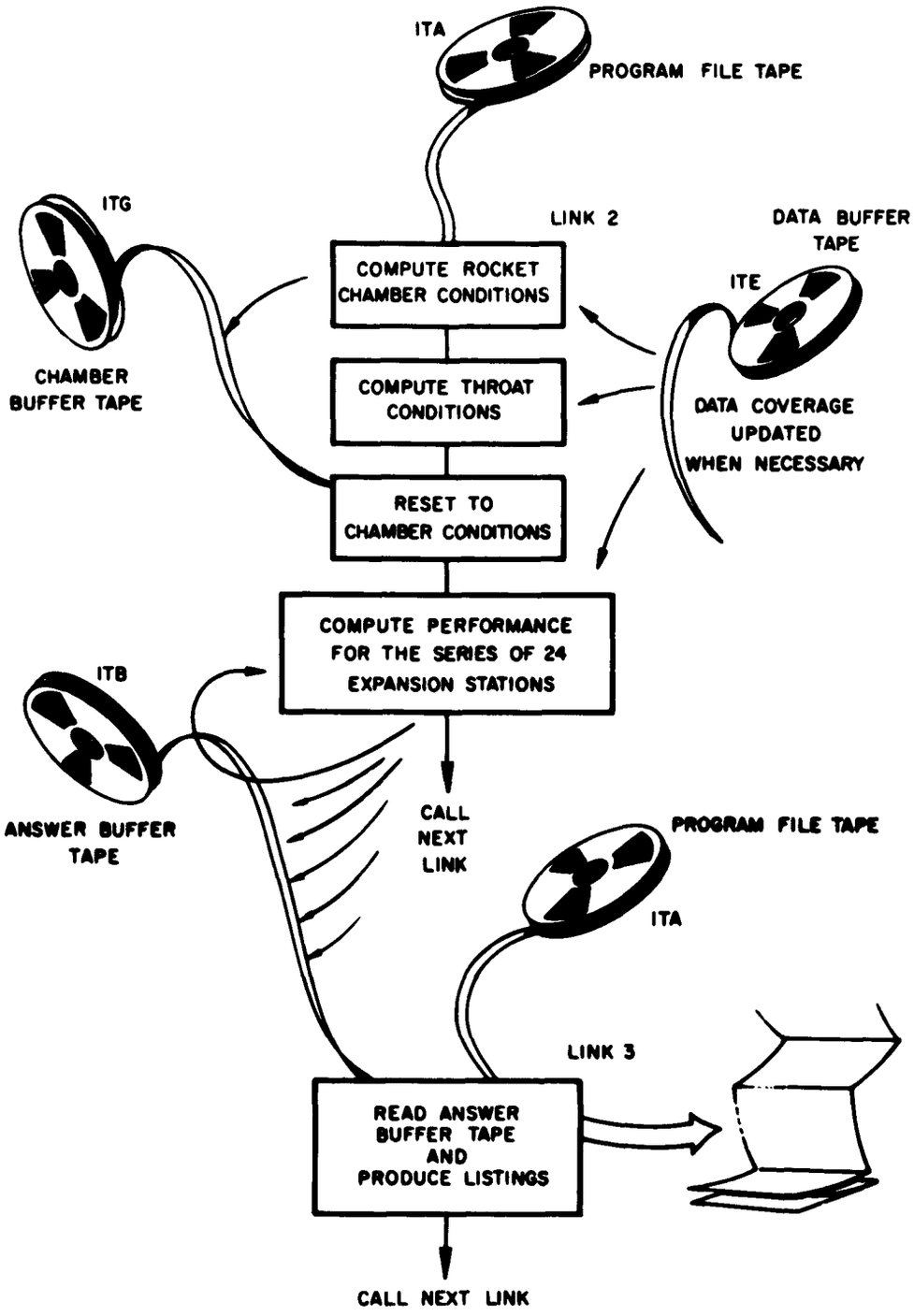

Fig. 2. Rocket Performance Link and Rocket Output Link

saved on the utility tape ITG. In the second phase, the matrix controls are altered to compute alternately acoustic velocity and isentropic expansion to Mach 1. These equations allow the program to determine the exact throat condition. When converged, the C* and area per unit system mass flow are stored. At this point, the chamber conditions are restored from ITG, and the last part of the program is begun.

The final phase is accomplished by solving an isentropic expansion equation system to expand to a specified series of pressures. This is handled by maintaining a series of pressure ratios (the first of which is 1.0) and successively dividing the chamber pressure by each of these. At each convergence, a series of answers are written on the answer buffer tape ITB, forming one column of TABLE ONE[2] and one row of TABLE TWO. The table of pressure ratios is selected to result in 1 atm pressure for a variety of chamber pressures and to result in a relatively smooth coverage of EPSILON (Area of flow/Area of throat) versus I_s. The computation link selects the output link after the pressure ratio list is worked through.

For the second and succeeding cases of a given problem, the rocket computation chain anticipates a better (faster) chamber convergence when the previous chamber conditions are used instead of the first guesses. Sometimes this faith is misplaced, especially when the new case differs drastically. Experience to date has shown that the total computer time is less for a series of cases when adjacent mixtures are not radically different. A simple rule of thumb would be that mixture ratios should change no more than 10 per cent.

3. Rocket Output, Link 3

This program (Fig. 2) produces the output sheets normally associated with the propulsion program. Answers are arranged in what is hoped is a readable manner. The TABLE THREE listings are produced by parabolic interpolation

[2] Capitalized names refer to the answer sheet titles.

on the epsilon from TABLE TWO. The off-design variables A and B are defined below.

$$IEPS = IOPT + \frac{P_e}{P_c}\frac{C^*}{g} EPSILON - \frac{P_o}{P_c}\frac{C^*}{g} EPSILON$$

$$= IOPT + A + BP_o$$

4. General Solver, Link 5

The general solver link (Fig. 3) is capable of solutions for three specific types of outputs: Mollier Diagram, Equilibrium Solution (at a series of temperatures for a given pressure), and Ambient Flame Solution. In the first two, the matrix is asked only to compute equilibrium at a specified pressure and temperature. The last type, Flame Solver, uses the specified pressure to find both the system composition and temperature using the available energy of the original ingredients. In all three cases, control is specified by an item on data card 5, and the program system relinquishes control to link 1 at the end.

5. Other Links

Other system programs now exist. Two of these are Shock Tube Performance and Detonation Velocity Solver. These will be reported on at a future time.

E. SYSTEM OPERATION

The programs contained in this system are coded in FORTRAN II and are designed to run in the CHAIN mode. Normal operation is separated into the maintenance of the program library tape and the use of the program library for production. The isolation of the production phase is efficient since the user is assured of access to the latest system, hopefully synonymous with the most powerful, and he does not have the responsibility of maintaining a usable, updated program deck.

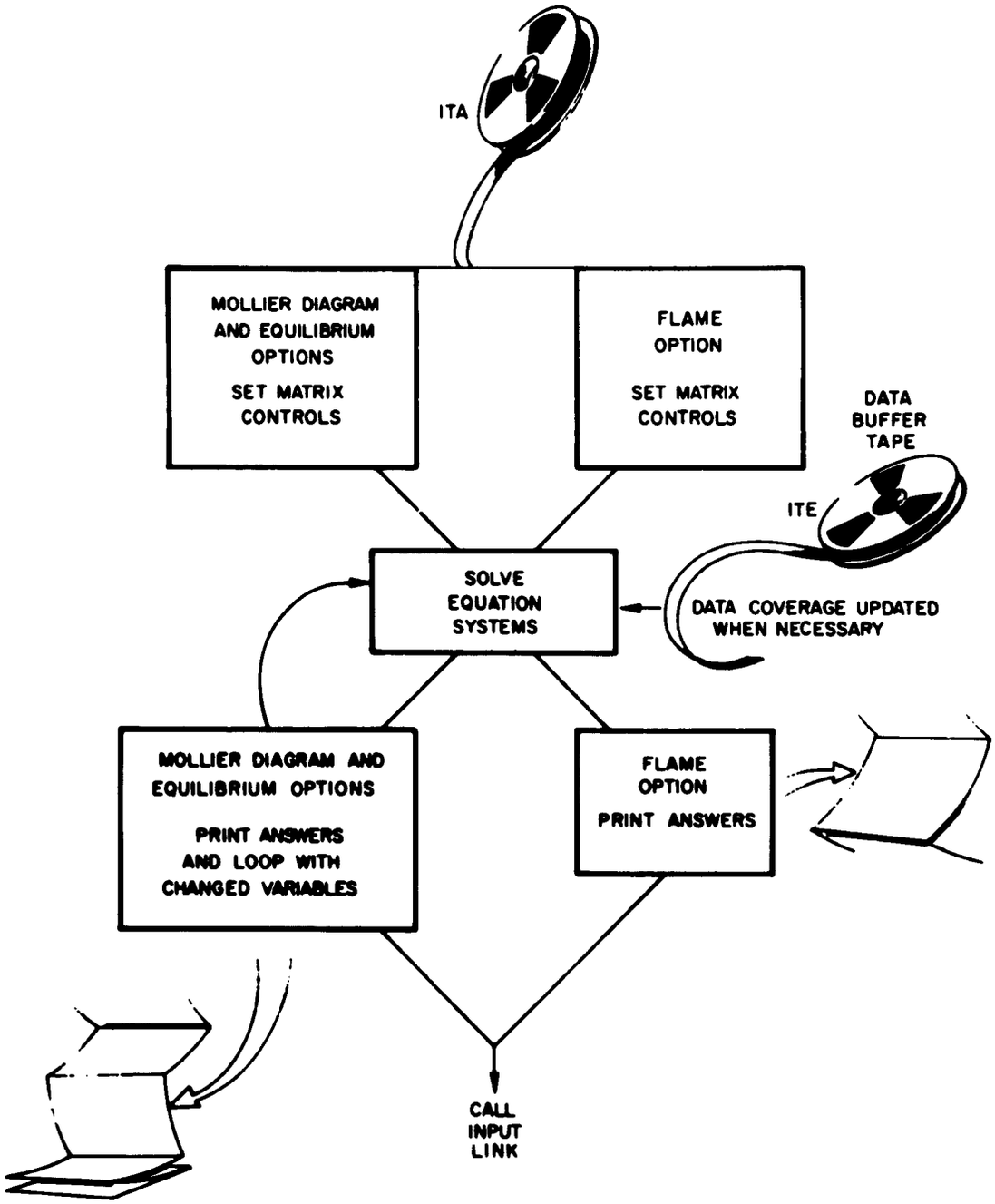

Fig. 3. General Solver Link

The system is updated by putting the program library tape on the computer and loading it with the entire system of programs. At this time, test cases may be run to verify proper operation of the chain system.

Production usage involves only the selection of the input link from the previously prepared program tape. The program system takes over to read the data, to select the solution required, and to produce answers.

III. PROGRAM USAGE

A. DATA REQUIRED

Appendix A details the format of all data cards. These cards are read with standard FORTRAN input statements. It should be noted that each problem begins with complete specification of the execution tape configuration. Thus, sequentially executed problems may use different thermodynamic data libraries.

The basic data deck starts with the above mentioned computer specification and control card. Available on this card are program control variables which may be used to dump program iterations or increase iteration limits. These controls should be used carefully since execution time will be increased.

Cards 2 and 3 are used as titles for all answer sheets. These cards are printed as a single line, alongside or below the identification of the thermodynamic data tape used. The character of the data tape identification is discussed later, but all answer sheets have this code as part of the page title.

Card 4 specifies the macroscopic logic of the problem, number of system ingredients, what type of solution required, and number and kind of combination of these ingredients.

Card 5 is the only data card which must be considered in light of the computation type requested. Obviously, different input is required for Mollier Diagrams and for Rocket Performance. These data are given on this card. Basically, this card describes the system variable limits or particular specifications.

Card types 6, 6.I, 7, 7.J, and 8.K specify the exact ingredients to be used, their proportions to each other, and any limitations on products to be used in the solution system.

B. THERMODYNAMIC DATA LIBRARY

The program system uses a data library tape containing several hundred product data sets. These sets are sorted in the first phase of the program, and applicable sets are written on a buffer tape. The overall data block contains the following items:

1) State indicator (1 if gas, 2 if condensed)

2) Name of product

3) Elemental structure of product arranged as a vector, as long as the elements contained in the tape and with corresponding vector elements being the atoms of that element contained in the molecule

4) Heat of formation in Kcal/mole at $298.16^{\circ}K$

5) Upper, lower, and discontinuity (if any) temperatures

6) Data tables of T, C_p, $\Delta H/^{T}_{298.16}$, and S for values of temperature from zero to $6000^{\circ}K$ in increments of 100°. Additional points have been inserted at 50°, 150°, and $250^{\circ}K$ to aid in low temperature interpolation.

A listing of the products contained on the tape and their heats of formation (at 298.16°) are given in Table 2. A subsequent report will give all programs necessary to put the JANAF (Ref. 2) data on this data library.

C. ANSWER DISCUSSION AND VERIFICATION

1. Rocket Performance

The test case chosen for rocket performance illustration is one of several standard systems which are run to verify a program change. The chamber

conditions match Ref. 3 relatively close considering that the most dominant products had heat of formation (at 298.159°K) differences of the following:

Product	References H_f	H_f Used
LiOH	-53.8	-57.7000
LiF	-77.6	-79.3000
Li_2O (cond)	-142.4	-143.0486
LiCl	-49.0	-46.7780

The general result of this energy difference was a slightly lower chamber temperature (53°K) and a 1 atm I_s increase of about 2 sec in the Aerospace answers.

The input data cards are printed as answers on the leading page. As products are qualified by the thermodynamic data tape search subroutine (SIFT), the product name and its heat of formation (at 298.159°K) are printed. The ingredient formulation card is read and printed out. Although weight per cent was specified, the moles and mole per cents of the ingredients were also computed and printed. All three are always printed when any one is specified. At this point, the system is broken down into the atoms of the elemental species per gram of entire system. The resulting numbers are the mass balance values used during the convergence of the problem. The mass balance may be verified by adding the atoms of the respective elements using TABLE ONE compositions.

As detailed elsewhere, the system energy (enthalpy) per system gram is altered depending upon the base values of the contained elements. The present list of base enthalpies are given in Table 2. The total propellant enthalpy is obtained by adding the heat of formation per mole of each constituent to that constituent's relative base enthalpy and then combining all constituent energies per mole according to the moles of each given in the mass balance printout. This value should check the chamber enthalpy given in the first column of TABLE ONE. The answers reported for enthalpy in

Table 2

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
H	52.102	$AlCl_2F$	-181.8
He	1.4812	AlF	-61.3
Li	38.41	Cl_3FSi	-201.
Be	77.922	SiF	10.9018
B	132.618	FPS	-41.
C	170.886	FP	-17.
N	112.965	PbFCl	-85.5613
O	59.5590	ClF	-13.501
F	18.86	FK	-76.
Ne	1.4812	FeF	-5.71
Na	25.7550	PbFBr	-76.4185
Mg	35.33	BrF	-19.3776
Al	78.00	PbF	-14.5068
Si	110.00	F^-	-63.0387
P	79.83	F_2Mg	-177.
S	66.44	$AlClF_2$	-235.
Cl	28.922	AlF_2	-157.
Ar	0.0	F_2Si	-118.
K	21.31	F_2P	-109.
Ca	46.0402	F_2K_2	-203.56
Ti	112.49	F_2Ti	-132.
Fe	96.4473	FeF_2	-108.8545
Ni	101.6102	F_2Zr	-146.7
Br	26.7096	PbF_2	163.0852
Rb	20.5102	F_2	0.
Zr	145.8	AlF_3	-285.448
Cd	26.9698	ClF_3Si	-315.
Cs	18.8302	SiF_3	-188.9357
Pb	46.3402	F_3P	-220.7
E	.0002	ClF_3	-38.79
HLiO	-57.7	F_3Ti	-255.3
HLi	32.1	FeF_3	-209.8056
BeHO	-41.0	F_3Zr	-271.1
BeH	77.37	F_4Si	-372.9
BHO	-47.127	F_4Ti	-369.6
BHO_2	-135.32	F_4Zr	-391.
BH	114.761	PbF_4	-183.1355
CHNO	-27.9	F_6S	-288.5
CHN	31.2	ClNa	-44.05
CHFO	-94.0	Na^+	144.2552
CHO	-2.9	ClMg	1.
$CHCl_2F$	-61.0	Cl_2Mg	-100.7
$CHClF_2$	-112.0	MgBr	-12.9488

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
FeO_2H_2	-44.8474	Li_2	50.4
$Fe_2O_3H_2$	-44.8221	F_3Li_3	-357.6
F_2H_2Si	-194.	Cl_3Li_3	-228.3
Cl_2H_2Si	-75.	BeC_2	135.
SiH_2Br_2	18.7389	BeO	30.44
H_2S	4.8150	BeClF	-124.
H_2P	76.3002	BeFBr	-126.3854
H_2	0.	BeF	4.816
BH_3O_3	-238.6	BeF_2	-182.8
BH_3	18.	BeClBr	-84.7217
$B_3H_3O_6$	-541.69	BeCl	36.989
CH_3F	-59.	$BeCl_2$	-80.38
CH_3Cl	-20.634	BeBr	-17.
CH_3	32.	$BeBr_2$	-58.886
H_3N	-11.040	Be^+	292.9235
H_3O^+	139.	Be_2O_2	-102.4
FeO_3H_3	-113.7178	Be_2Cl_4	-185.
FH_3Si	-105.	Be_3O_3	-259.8
ClH_3Si	-48.	Be_4O_4	-377.2
SiH_3Br	29.8534	Be_5O_5	-493.6
SiH_3	23.7276	Be_6O_6	-631.1
H_3P	6.43	BN	151.748
CH_4	-17.9251	BFO	-142.923
C_2H_4O	-12.19	BClO	-84.811
C_2H_4	12.496	BO^+	167.1494
H_4Si	7.8	BO	3.744
B_2H_6	7.53	BClF	-77.8
$B_3H_6N_3$	-124.2	BCl_2F	-153.97
CH_6	-17.895	$BFBr_2$	-122.8872
B_5H_9	15.02	BF	-45.469
$B_{10}H_{14}$	2.8	$BClF_2$	-211.65
FLiO	-10.	BF_2Br	-196.4394
ClLiO	-3.4	BF_2	-133.843
LiN	39.0	BF_3	-270.
LiO	14.0	BS	70.5
FLi	-79.3	$BClBr_2$	-65.2485
ClLi	-43.8	BCl	43.2
LiBr	-42.1411	BCl_2Br	-81.176
Li^+	161.6507	BCl_2	-19.62
Li_2O	-34.1	BCl_3	-97.1
$ClFLi_2$	-180.2	BBr	59.498
F_2Li_2	-213.5	BBr_3	-60.4
Cl_2Li_2	-140.8	B^+	326.5228

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
B_2O_2	-111.6	C_2F_4	-151.7
B_2O_3	-210.1	Al_2C_2	120.042
B_2Cl_4	-118.5	SiC_2	160.143
B_2	199.3	Si_2C_2	301.6619
$B_3F_3O_3$	-567.	C_2^+	473.304
$B_3Cl_3O_3$	-402.	C_2	197.028
CFN	-12.8	C_3O_2	-8.3
CClN	31.6	Si_2C_3	165.0888
CN^-	21.0504	C_3	189.67
CN	94.	C_4N_2	127.5
CClFO	-106.5	C_4	242.321
CF_2O	-150.2	C_5	242.374
COS	-33.08	FNO	-15.65
CCl_2O	-52.4	ClNO	12.6
CO^+	305.6472	NO^+	234.8979
CO	-26.417	NO	21.6520
CO_2^+	223.7088	NO_2	8.060
CO_2	-94.054	FN	58.6
CCl_3F	-71.	F_3N	-29.7
CF^+	349.4422	AlN	104.5
CF	74.4	NSi	121.0
CF_2Cl_2	-59.1725	NP	21.59
CF_2^+	225.4683	NS	-54.0
CF_2	-46.	N^+	449.565
$CClF_3$	-171.9	N_2O	19.5
CF_3^+	94.1467	N_2O_3	20.185
CF_3	-130.	N_2O_4	10.5540
CF_4^+	192.8418	N_2O_5	3.06
CF_4	-218.	N_2^+	359.8
AlC	209.958	N_2	-0.
SiC	192.1625	AlFO	-121.
Si_2C	127.0336	OSiF	82.424
Si_3C	-14.7543	FeFO	-87.2606
CP	93.	PbOF	-73.0613
CS	71.5	FO	32.4
CS_2	27.55	F_2SiO	219.0843
CCl	132.	F_2OS	-113.
CCl_4	-25.94	F_2O	7.6
C^-	143.5641	NaO	13.2
C^+	197.2641	MgO	4.1900
C_2N_2	73.87	AlClO	-55.
$C_2F_2^+$	180.4322	AlO	17.387
C_2F_2	-51.3	Al_2O^+	140.7249

Table 2 (Cont'd)

Products Contained in the Library and Their H_f

Product	H_f	Product	H_f
Al_2O	-39.4	CHF_3	-162.6
OSiCl	53.6395	$CHCl_3$	-25.0
Cl_2SiO	107.2549	CH	142.006
OSi	21.411	HNO	14.089
Cl_3OP	-134.6	HN	79.2
OP	-1.455	FHO	-26.1
OS	-.12	HNaO	-55.44
FeClO	-37.9748	HMgO	-12.2
PbOCl	-39.4235	AlHO	-3.447
ClO	24.192	ClHO	-21.4
Cl_2O	18.1	FeOH	-9.7882
OTi	15 1	OH^-	-31.7425
FeO	64.2042	HO	9.33
Fe_2O	80.6257	$AlHO_2$	-109.0
PbOBr	-30.2816	FeO_2H	-55.673
OZr	24.7	HF^+	299.5394
PbO	6.0573	FH	-64.5
O^-	25.0501	F_3HSi	-283.
O^+	373.1501	HNa	29.88
F_2O_2S	-150.	HMg	40.7
Al_2O_2	-105.28	AlH	61.7
O_2Si	-73.9	Cl_3HSi	-112.
O_2P	-73.0	$HSiBr_3$	79.0481
O_2S	-70.96	HSi	114.
ClO_2	25.	HP	54.9
O_2Ti	-79.8	HS	32.0
Fe_2O_2	13.3972	HCl^+	271.7486
O_2Zr	-71.5	ClH	-21.97
PbO_2	-26.6111	HBr	-12.277
O_2^-	-3.53	PbH	60.9805
O_2^+	371.3	$H_2Li_2O_2$	-169.4
O_2	0.	BeH_2O_2	-156.7
$ClFO_3$	-5.12	BeH_2	30.
O_3S	-94.45	BH_2O_2	-45.
Fe_2O_3	-53.5267	BH_2	66.
O_3	34.	CH_2O	-27.7
O_6P_4	-684.905	CH_2ClF	-58.
$O_{10}P_4$	-681.9	CH_2F_2	-105.5
FNa	-67.	CH_2Cl_2	-22.4
Na_2	32.87	CH_2	66.835
ClFMg	-136.9	C_2H_2	54.19
FMg	-21.	H_2N	40.3
AlClF	-123.	H_2O	-57.798

Table 2 (Cont'd)

Products Contained in tne Data Library and Their H_f

Product	H_f	Product	H_f
Mg^+	210.903	Cl_3Zr	-153.8
AlS	69.	Cl_4Ti	-182.4
AlCl	-11.3	Cl_4Zr	-208.8
$AlCl_2$	-78.	$PbCl_4$	-134.1344
$AlCl_3$	-139.022	BrK	-42.58
AlBr	0.	K^+	121.5102
$AlBr_3$	-101.197	K_2	30.374
Al^+	216.5936	Br_4Ti	-131.329
Al_2Cl_6	-312.11	PbBr	11.3366
Al_2Br_6	-230.948	$PbBr_2$	-33.8686
Al_2	106.1479	Br_2	7.387
SSi	16.926	$PbBr_4$	-88.8482
ClSi	48.1	CS^+	108.5302
Cl_2Si	-37.66	Li liquid	0.
$BrSiCl_3$	-83.1311	Be cond	0.
Cl_4Si	-145.7	B cond	0.
SiBr	32.8389	C solid	0.
$SiBr_2$	-26.9442	Mg solid	0.
$SiBr_3$	-87.1206	Al cond	0.
$SiBr_4$	104.1263	Si cond	0.
Si_2	137.	P cond	0.
Si_3	145.9	Fe cond	0.
Cl_3PS	-91.	LiOH cond	-116.6699
PS	22.5	$LiAlO_2$ cond	-284.3111
Cl_3P	-62.5	LiF cond	-146.1759
Cl_5P	-84.63	LiCl liquid	-94.4642
P_2	42.83	Li_2O cond	-143.0486
P_4	31.03	Li_3N cond	-51.5771
PbS	-286.1165	BeO cond	-143.0976
MgS	33.2	Be_2C cond	-22.2151
S_2	30.84	Be_3N_2 cond	-135.4728
S_8	24.51	BN solid	-60.2938
ClK	-51.175	$NaBO_2$ cond	-234.9039
ClTi	17.	B_2O_3 cond	-305.3443
FeCl	43.4989	B_4C cond	-12.2046
PbCl	0.6055	$Na_2B_4O_7$ cond	-795.4951
Cl^-	-57.0563	AlN solid	-74.9299
Cl_2K_2	-147.85	Mg_3N_2 solid	-113.3437
$FeCl_2$	-41.6859	MgO solid	-144.1931
Cl_2Zr	-92.	FeO cond	-63.4894
$PbCl_2$	-51.9985	$NaAlO_2$ cond	-273.616
Cl_2	0.	SiO_2 cond	-207.4485
$FeCl_3$	-62.0048	TiO_2 liquid	-216.0349

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f
ZrO_2 liquid	-270.1879
Al_2O_3 cond	-400.6065
Fe_2O_3 cond	-200.0143
Fe_3O_4 cond	-266.2888
Al_2SiO_5 cond	-655.597
MgF_2 liquid	-259.0197
FeF_2 cond	-178.1306
AlF_3 cond	-355.2036
FeF_3 cond	-242.1555
$MgCl_2$ cond	-153.7136
$AlCl_3$ liquid	-162.3365
$FeCl_2$ cond	-79.6529
$FeCl_3$ cond	-96.0793
Br_2K_2 crystal	-126.16

this table are to be thought of as static enthalpies and contain no kinetic energy terms. Thus, the difference between the chamber enthalpy and any subsequent expansion station enthalpy is proportional to the square of the vacuum specific impulse available in a rocket physically terminated at that station. The formula used in the program to obtain the values in the right column of TABLE TWO is the following:

$$I_{s\,(\text{exit station})} = 294.98 \sqrt{\Delta H_{\text{chamber - exit station}}}$$

Each enthalpy may be verified by accumulating the products of the moles of each gas product times its total relative enthalpy for the gas temperature.

TABLE THREE is essentially an interpolation of data from TABLE TWO. Area ratios, or EPSILON values, from TABLE TWO are interpolated using a quadratic curve fit to obtain I_{opt}, C_F, and PC/PE for integer EPSILONs. The relationship between the other variables can now be found using the equations given under the discussion of the rocket performance output link.

TABLE TWO values of EPSILON become progressively farther apart as the expansion plane static pressure decreases. Thus, EPSILONs above about 50.0 are numerically illogical to use for interpolation purposes.

2. Flame Temperature Solution

The solution of the flame temperature given the rocket chamber pressure instead of 1 atm, results in verification of the chamber temperature and products. In this case, all products are listed in whatever amount they exist since trace compounds may be of interest. The enthalpy column gives the total relative enthalpy at the specified temperature.

3. Mollier Diagram Solution

The same case as above was run on the Mollier Diagram option. The diagram is plotted as Fig. 4. Note that the lower temperature conditions result in many more condensed species than would exist in the rocket system. The enthalpy printed is the system total relative enthalpy.

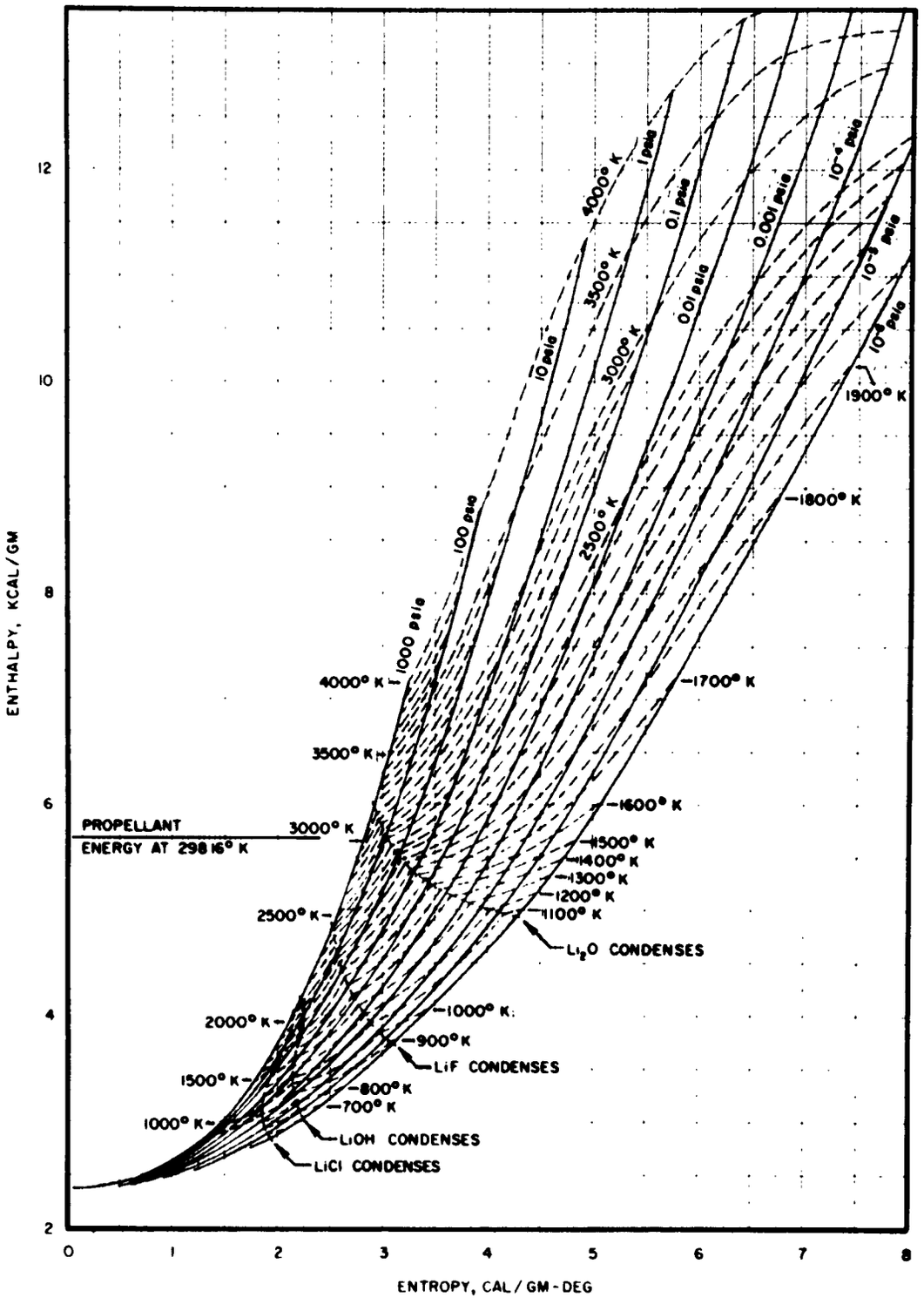

Fig. 4. Mollier Diagram of Sample Problem

4. Equilibrium Solution

Capability to compute a charge balance is in all the program systems. However, it has been used most extensively in the equilibrium option. This case was chosen to illustrate the disappearance of a component (the charged species) entirely. The program considers the electron charge in the same manner as an elemental constituent. Thus, the unique requirement of zero mass balance may be used wherever appropriate. The output listings are quite self-explanatory in headings and units of the variables.

Basically, the Equilibrium Solver works down a specified adiabat of the Mollier Diagram, while the Flame Solver gives a single point at the intersection of the adiabat and the system enthalpy.

IV. ITERATION ERRORS

The overall iteration procedure followed in this system is to solve the error matrices for corrections to the independent variables, apply them, solve for dependent variables, and repeat. The matrix answers can be treated both as meaningful variable increments and as error indicators. Table 3 gives the sum of the absolute value of the errors of the sample case as a function of the problem iteration. The Newtonian iteration method converged rapidly in this case, since the initial temperature guess was a fortunate one. Normally, the initial estimate is much further from the convergence solution, and in these cases the matrix answers cannot be used in altering the variables. The program has a fixed limitation on the size of the increment permitted. These values can be changed, but they now stand as ±5.0 for changes to major product partial pressure logarithms and 1.0 for changes to the average molecular weight logarithm. The system temperature is never allowed more than a 10 per cent change in either direction.

Table 3

Iteration Errors in the Sample Problem

Iteration	Rank of Error Matrix	Temperature (°K)	$\Sigma\lvert\epsilon\rvert$	Comments
1	6	3000.0	25.872	Initial Guesses
2	6	3000.0	21.963	
3	6	3000.0	9.6484	
4	6	3000.0	1.21141	
5	6	3000.0	0.12599	
6	6	3000.0	0.00114	
7	6	3000.0	$<10^{-6}$	
8	7	3000.0	10.34375	$Li_2O_{(c)}$ in
9	7	3000.0	5.0998	
10	7	3000.0	13.7603	
11	7	3000.0	1.2142	
12	7	3000.0	0.06053	
13	7	3000.0	0.000194	
14	8	3004.54	0.16606	Temp released
15	9	3004.54	$<10^{-3}$	
16	10	3004.54	$<10^{-5}$	Chamber done

As some indicator of the difficulty of convergence in the rocket link, three numbers are always printed just ahead of the main answers. These numbers give the number of chamber, throat, and expansion iterations.

V. PROGRAM SYSTEM ALTERATION

The logical design of this chemistry solving system is such that a great deal of flexibility is allowed. This occurs in two ways. If a new kind of solution is required which needs only the basic equilibrium, mass balance, and energy balance equations, a new main program link can be written incorporating whatever external restrictions are desired. An example of this is the detonation solver link which satisfies the Chapman-Jouget and Rankine-Hugoniot equations using only the basic solver package. If alterations to the basic equations are required, the specific subroutine may be modified, leaving all main program links able to incorporate the new capabilities. An example of this is alteration of the general gas law equation to some variation of Van der Waal's equation. The most common variation is Abel's equation $P(V - b) = RT$, where intermolecular forces are ignored, but the molecular volume is considered. The Virial equation has already been incorporated into the detonation link. Another example of program equation alteration might be the changing of the equilibrium subroutine to use rate coefficients in the Arrhenius equation to determine the relationship between the independent (major) species and the remainder.

VI. METHOD USED

It is assumed that the reader is familiar with both the matrix construction and the notation used in Refs. 1, 4, and 5; therefore, they will not be repeated. The matrix to be solved is basically the one described there, except that the matrix order is changed to solve for corrections to the current major products, and a charge balance equation is added to allow compilation with ionic species present. The only alterations required to the basic matrix scheme are the equilibrium equations and, of course, the placement of column variables.

Equilibrium definition in terms of any species may be reduced to the following procedure. First, the problem is defined in terms of the elemental species forming the original ingredients. The list of elements thus specified is used to select all possible or allowed species from the data library tape. The chosen species have their respective elemental subscripts placed in a vector array corresponding to the position of the subscripted element. Thus, any products chosen have coefficient vectors whose positions are related to the original element vector. By a program ground rule, as many products are picked as majors as there are elements in the problem. The product coefficient vectors thus form a square matrix based on the row element order. This is illustrated in Appendix B, Section I.

The coefficient matrix is examined by the program for two necessary conditions. Each element must be represented in some product, but may be in several products, and there can be no two products whose elemental subscripts are linearly dependent. For example, OH and H_2O_2 can never simultaneously exist as major products. If these conditions are satisfied, this matrix is inverted and used to define the equilibrium relationships between all other species and the major products forming this matrix. References 1 and 3 would have a unit matrix at this point. Equilibrium coefficients are automatically obtained in Appendix B, Section I.

The important characteristic of this matrix is the simplicity with which the major products can change. The change procedure is the comparison of molar quantities of the chosen majors with the other species available. When one of the nonmajor species exists in an amount significantly larger than a chosen major, the majors are repicked allowing the newly dominating species to become a major product. Thus, the major product species remain those in largest quantity, independent of temperature and pressure level.

The basic matrix formed from mass balance, pressure conservation, and energy conservation equations is constructed as illustrated in Appendix B, Section II. The upper left submatrix is still a unit matrix. The lower left matrix is built with column entries which are dependent on the species appearing and are in the same sequence as the rows in the upper right submatrix. In the method outlined here, all equilibrium equations are always satisfied, so the error entry in the upper right submatrix is always zero. The reduction of the three matrices is accomplished by normal matrix arithmetic and poses no problem.

Two basic types of trouble can occur in thermochemical programs. The first, iteration control, is solvable using experience with the general solution system and the type of problems computed in each computation chain. In general, each type of computation requires its own iteration control and dependent variable limitations. However, most of the iteration searching is eliminated if the iteration temperature is severely limited in its change. The programs described here incorporate a linearly varying temperature increment/decrement upper bound which changes from about $100^{\circ}K$ at $3000^{\circ}K$ to about $15^{\circ}K$ at $300^{\circ}K$. The temperature increment obtained from the iteration variables is tested before being applied; and if it falls outside this boundary, the boundary limit change is used instead. In cases of crystallizing liquids, the discontinuity temperature is maintained constant until all system variables except energy have been satisfied.

First guess problems are approached as if the program were to use the atomic species as major products. Choices of the atomic partial pressures are made. The system temperature is fixed at a constant, high value, and the gas species equilibrium is computed. Any condensible products are allowed to appear. System major products are chosen, and the problem is released for general solution.

The first guesses for the atomic species are chosen using the following formula.

$$p_i = FG_i * M_i * P_c * 25$$

where

P_c = system pressure

M_i = moles per gram system weight of the atomic type

FG_i = the value found in a lookup of the elemental species

The FG table is given in Appendix C.

APPENDIX A

How to Write Data for the N Element Chemistry System

The cards in the order required, starting with the first card after the
* DATA control card are the following:

1. Computer specification and control card
2. Title card #1 (columns 1 through 72)
3. Title card #2 (columns 1 through 36)
4. Problem specification card
5. Special option card
6. System component title and specification card

6.1 Component element card

cards 6. and 6.1 repeat for as many components as are specified on problem spec card(#4)

7. Control number for included/excluded products

7.1 Included/excluded product #1

.
.
.

7.J Included/excluded product #J

cards 7.J repeat for as many as are required

NOTE: cards 7 through 7.J are needed only when control card #1 indicates it. Otherwise they are omitted.

8.1 Component combination card #1

.
.
.

8.K Component combination card #K

cards 8 K repeat for as many combinations as are requested in cards #4

Program chooses next problem starting at card #1, after reading all 8.K cards.

INDIVIDUAL CARD BREAKDOWN

CARD NO. 1

ITEM	COLUMNS	NORMALLY	DEFINITION
ITA	1-3	16 in cols 2, 3	Program Chain Unit*2
ITB	4-6	4 in col 6	Answer Buffer Unit
ITC	7-9	9 in col 9	Program Loop Recover Unit
ITD	10-12	5 in col 12	Thermo Library Unit
ITE	13-15	10 in cols 14, 15	Thermo Data Buffer Unit
ITF	16-18	4 in col 18	Chamber Condition Buffer Unit
ITG	19-21	14 in cols 20, 21	Expansion System Recovery Unit
ITH	22-24	4	System Condition Buffer
ITI	25-27	2 in col 27	System Input Tape Unit
ITO	28-30	3 in col 30	System Output Tape Unit
IP	31-33	± in col 32, 1 or 0*1 in col 33	Product inclusion/exclusion Control
IT*3	43-45	Normally ZERO or blank. For program iteration dump put 1 in col 45	
IU	46-48	Normally ZERO or blank. For program iteration dump, put 1 in col 48	

*1 If IP is +1, the program is to allow all selected products except those specified.

If IP is 0 or blank, the program chooses all possible products.

If IP is -1, the program allows only the specified products to be considered in the solution.

*2 IBM allows this number to be two (2) for B-2, three (3) for B-3, or A-4 for anything else, we have modified the chain selecting routine so that a "16" selects tape B-8.

The "16" is used for production runs, where the chain library has been previously created and is now mounted on unit B-8. When the chain program library is to be made, and a trial calculation completed. an 11 is required, since the program tape is written on tape B-3.

*3 If IT is made to be -1 on the control card, the number of allowable iteration loops (before terminating problem) is doubled. This control should not normally be used except in cases of extremely large numbers of elements and condensibles appearing, and only then when it has been proven that the problem would have converged if allowed to iterate longer.

CARD NO. 2 and 3

Any alphabetically punched title, which will be printed at the top of all answer sheets.

CARD NO. 4

ITEM	COLUMNS	DEFINITION
IH	1-12*	Input style code 1 in col 12 if moles given in cards 8. J 2 in col 12 if mole percents 3 in col 12 if weight percents 4 in col 12 if mixture ratio 5 in col 12 if oxidizer ratio
IJ	13-24*	This is the computation control number

To compute	IJ is	Program
Rocket Perf.	1	chain link 2
Mollier Diag.	2	
Flame Solution	2	chain link 5
Equil. Solution	2	
Shock Perf.	4	chain link 11

Chain link 5 computes any of the three available options depending on the value of the last item on card 5. See card 5 detail description.

IK	25-36*	The number of total propellant components This can be any number up to 15 for IH = 1, 2, or 3, but is always 2 (in col 36) for IH = 4 or 5

ITEM	COLUMNS	DEFINITION
IL	37-48*	The number of combinations of these propellants

* All numbers are right oriented within the field given (i.e., an IH of 1 would be in col 12)

CARD NO. 5

The content of this card varies with the program chain used (the IJ in card 4). Each item has the card position as follows:

ITEM	COLUMNS	DECIMAL PLACE IN COLUMN
1	1 → 12	6
2	13 → 24	18
3	25 - 36	30
4	37 - 48	42
5	49 - 60	56
6	61 - 72	68

For IJ = 1 (Rocket Performance)

ITEM	IS
1	Chamber pressure in psia
2	Not used
3	Chamber Temperature guess if desired, otherwise may be left blank and program chooses 3000°K
4, 5, 6	Not used

For IJ = 2 (Mollier Diagram)

ITEM	IS
1	Upper pressure boundary (psia)
2	Lower pressure boundary (psia)
	- the program drops the pressure by a factor of 1/10 until the lower boundary is reached.
3	Upper temperature boundary (°K)
4	Lower temperature boundary (°K)
5	Temperature decrement
	- the program always computes the lower temperature point so the decrement does not have to exactly fit between the temperature boundaries
6	1. (specifies Mollier Diagram)

For IJ = 2 (Equilibrium Solution)

ITEM	IS
1	Pressure (psia)
2	Not used
3	Upper temperature (°K)
4	Lower temperature (°K)
5	Temperature decrement (°K)
6	2. (Specifies Equilibrium Solution)

For IJ = 2 (Flame Solution)

ITEM	IS
1	Pressure (psia)
2, 3, 4, 5	Not used
6	3. (specifies Flame Solution)

CARD NO. 6

ITEM	COLUMNS	DEFINITION
Name	1 - 24	Component alphabetical name. Any combination is allowable for IH = 1 2, or 3. For style 4 and 5, one of the propellants must contain the letters FUEL in columns 19 through 22 with columns 23 and 24 blank
ΔH_f	25 - 36	Heat of formation of the molecule in KCAL/MOLE. Decimal place in column 31
	41, 42	The number of atomic species forming the molecule (right oriented)
	43 - 72	Any information desired. These columns are not read nor used. It is suggested that information be placed here as to the reference for the heat of formation

In order to allow computation using ionized molecules, the user must specifically select the electron gas as if it were a part of the composition. This may be done by using the name ION in columns 1-3 with zero heat of formation and one atomic species indicated in column 42. Card 6.1 would contain E in column one and 1.0 in columns 5, 6 and 7. See card 8 detailed write-up for quantity specification.

CARDS NO. 6.1

ITEM	COLUMNS	DEFINITION
Element Name	1 - 2	The standard chemical abbreviation* for one of the elements contained in the immediately preceding component card 6.
Coefficient	3 - 12	The numerical coefficient associated with the above element. Decimal point in col 6 or 7.
Element Name	13 - 14	The abbreviation for the next element*.
Coefficient	15 - 24	The coefficient for this element.

The groups of 2 cols for element name and 10 cols for its coefficient continue across the card.

	#1	#2	#3	#4	#5	#6
Element	1-2	13-14	25-26	37-38	49-50	61-62
Coefficient	3-12	15-24	27-36	39-48	51-60	63-72
Decimal	6	18	30	42	56	68

A maximum of 15 elements are allowed for each component ingredient. A maximum of 15 component ingredients are allowed (IH = 1, 2 or 3) for each total system.

* Since there may be some question as to what is the standard chemical abbreviation, a list of the element names used in the program follows:

H	N	AL	K	RB
HE	O	SI	CA	ZR
LI	F	P	TI	CD
BE	NE	S	FE	CS
B	NA	CL	NI	PB
C	MG	AR	BR	E (electron gas)

CARD NO. 7 (OPTIONAL)

Col 1-12 (right orient on 12) contains the number of included/excluded products.

CARDS NO. 7. J (OPTIONAL)

Exact product name in cols 1-12 with its state indicator (1 if gas, 2 if condensed or solid) in cols 13, 14*

One product per card.

CARDS NO. 8. K

Combination specification of system components in the order of their data cards. All are in floating point notation in the following manner:

NUMBER	FRACTION COLS	±	EXPONENT
1	2-9	10	11, 12
2	14-21	22	23, 24
3	26-33	34	35, 36
4	38-45	46	47, 48
5	50-57	58	59, 60
6	62-69	70	71, 72

If more than 6 components form the system, the combination specs follow on the next card.

When systems are computed including ionic species, the number of moles (weight percent, mole percent) of the electron gas must be exactly zero.

* Complete sets of these cards will be furnished upon request.

APPENDIX B

Example of Matrix Construction

Section I

Sample system of elements

H
O
Al

Potential products

H	AlO	
O	Al_2O	
Al	O_2	
OH	Al_2O_2	
AlOH	O_3	
AlH	Al_2O_3	(crystal)
H_2	Al	(crystal)
H_2O	H_2O	(liquid)

As an example, it will be assumed that the following have been chosen by the computer routine as major products.

H_2
H_2O
Al

The coefficient matrix and its inverse are

$$C.M. = \begin{array}{c} \\ H \\ O \\ Al \end{array} \begin{array}{c} \begin{array}{ccc} H_2 & H_2O & Al \end{array} \\ \begin{pmatrix} 2 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array} \qquad C.M.^{-1} = \begin{array}{c} \\ H \\ O \\ Al \end{array} \begin{array}{c} \begin{array}{ccc} H_2 & H_2O & Al \end{array} \\ \begin{pmatrix} 1/2 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array}$$

Each equilibrium coefficient row E_i can be determined as for Al_2O_3

$$E_{Al_2O_3} \begin{array}{c} \\ H \\ O \\ Al \end{array} \begin{array}{c} \begin{array}{ccc} H_2 & H_2O & Al \end{array} \\ \begin{pmatrix} 1/2 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array} \begin{array}{c} Al_2O_3 \\ \begin{pmatrix} 0 \\ 3 \\ 2 \end{pmatrix} \end{array} = (-3 \;\; 3 \;\; 2)$$

which would define equilibrium between Al_2O_3 and the majors as

$$-3H_2 + 3H_2O + 2Al \rightleftharpoons Al_2O_3$$

resulting in

$$K_{Al_2O_3} = \frac{p_{Al_2O_3}}{p_{H_2}^{-3} \; p_{H_2O}^{3} \; p_{Al}^{2}}$$

or

$$\ln K_{Al_2O_3} + 3 \ln p_{H_2} - 3 \ln p_{H_2O} - 2 \ln p_{Al} = \ln p_{Al_2O_3}$$

The generalized equation is

$$E_j = (C.M.^{-1})(c_j)$$

Section II

Following the matrix scheme outlined in Ref. 1, 4, and 5, the basic error matrix for the solution of an H, O, Al system which contains Al_2O_3 crystal, solving mass balance, equilibrium, pressure conservation, and energy conservation may be partitioned into

$$\left(\begin{array}{c|c} a_1 & a_2 \\ \hline a_3 & a_4 \end{array}\right)$$

where a_1 equals an identity matrix.

$$-a_2 = -\begin{bmatrix} \delta \ln p_{H_2} & \delta \ln p_{H_2O} & \delta \ln p_{Al} & \delta \ln n_{Al_2O_3(c)} & \delta \ln A & \delta \ln T & \epsilon \\ (& E_H &) & 0 & 0 & q_H & 0 \\ (& E_O &) & 0 & 0 & q_O & 0 \\ (& E_{OH} &) & 0 & 0 & q_{OH} & 0 \\ (& E_{AlOH} &) & 0 & 0 & q_{AlOH} & 0 \\ (& E_{AlH} &) & 0 & 0 & q_{AlH} & 0 \\ (& E_{AlO} &) & 0 & 0 & q_{AlO} & 0 \\ (& E_{Al_2O} &) & 0 & 0 & q_{Al_2O} & 0 \\ (& E_{O_2} &) & 0 & 0 & q_{O_2} & 0 \\ (& E_{Al_2O_2} &) & 0 & 0 & q_{Al_2O} & 0 \\ (& E_{O_3} &) & 0 & 0 & q_{O_3} & 0 \end{bmatrix}$$

$$
a_3 = \begin{array}{c} \\ \sigma_H \\ \sigma_O \\ \sigma_{Al} \\ Al_2O_3(c) \\ \Sigma p_i \\ \Sigma h' \end{array}
\begin{array}{c}
\begin{array}{ccccccccccc} H & O & OH & AlOH & AlH & AlO & Al_2O & AO_2 & Al_2O_2 & O_3 \end{array} \\
\left[\begin{array}{ccccccccccc}
p_H & 0 & p_{OH} & p_{AlOH} & p_{AlH} & 0 & 0 & 0 & 0 & 0 \\
0 & p_O & p_{OH} & p_{AlOH} & 0 & p_{AlO} & p_{Al_2O} & {}^2p_{O_2} & {}^2p_{Al_2O_2} & {}^3p_{O_3} \\
0 & 0 & 0 & 0 & p_{AlH} & p_{AlO} & {}^2p_{Al_2O} & 0 & {}^2p_{Al_2O_2} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
p_H & p_O & p_{OH} & p_{AlOH} & p_{AlH} & p_{AlO} & p_{Al_2O} & p_{O_2} & p_{Al_2O_2} & p_{O_3} \\
h'_H & h'_O & h'_{OH} & h'_{AlOH} & h'_{AlH} & h'_{AlO} & h'_{Al_2O} & h'_{O_2} & h'_{Al_2O_2} & h'_{O_3}
\end{array}\right]
\end{array}
$$

$$
a_4 = \begin{array}{c} \\ \sigma_H \\ \sigma_O \\ \sigma_{Al} \\ Al_2O_3(c) \\ \Sigma p_i \\ \Sigma h' \end{array}
\begin{array}{c}
\begin{array}{ccccccc} \delta \ln p_{H_2} & \delta \ln p_{H_2O} & \delta \ln p_{Al} & \delta \ln An_{Al_2O_3(c)} & \delta \ln A & \delta \ln T & \epsilon \end{array} \\
\left[\begin{array}{ccccccc}
{}^2p_{H_2} & {}^2p_{H_2O} & 0 & 0 & -Aa_H & 0 & \epsilon_H \\
0 & p_O & 0 & {}^3p_{Al_2O_3(c)} & -Aa_O & 0 & \epsilon_O \\
0 & 0 & p_{Al} & {}^2p_{Al_2O_3(c)} & -Aa_{Al} & 0 & \epsilon_{Al} \\
(& E_{Al_2O_3(c)} &) & 0 & 0 & q_{Al_2O_3(c)} & \epsilon_{Al_2O_3(c)} \\
p_{H_2} & p_{H_2O} & p_{Al} & 0 & 0 & 0 & \epsilon_p \\
h'_{H_2} & h'_{H_2O} & h'_{Al} & h'_{Al_2O_3(c)} & -Ah & TC' & \epsilon_H
\end{array}\right]
\end{array}
$$

APPENDIX C

Initial Guess Constants

Initial guess constants for elements now contained on the thermodynamic data tape are as follows.

Element	FG	Element	FG
H	2.8×10^{-3}	Ca	1.0×10^{-3}
He	1.0	Sc	1.0×10^{-3}
Li	4.5×10^{-4}	Ti	1.0×10^{-5}
Be	2.0×10^{-6}	Cr	1.0×10^{-3}
B	8.1×10^{-6}	Fe	1.0×10^{-3}
C	1.4×10^{-10}	Co	1.0×10^{-3}
N	3.0×10^{-6}	Ni	1.0×10^{-3}
O	1.1×10^{-5}	Ca	1.0×10^{-3}
F	2.0×10^{-2}	Fn	1.0×10^{-3}
Ne	1.0	Br	1.0×10^{-3}
Na	1.2×10^{-3}	Ag	1.0×10^{-3}
Mg	4.5×10^{-4}	Cd	1.0×10^{-3}
Al	1.5×10^{-7}	I	1.0×10^{-3}
Si	1.0×10^{-6}	Cs	1.0×10^{-3}
P	2.9×10^{-2}	Ba	1.0×10^{-3}
S	7.9×10^{-2}	Hg	1.0×10^{-3}
Cl	1.0×10^{-6}	Pb	1.0×10^{-1}
Ar	1.0×10^{-3}	Bi	1.0×10^{-3}
K	1.0×10^{-3}	U	1.0×10^{-3}
		e	1.0×10^{-10}

APPENDIX D

Rocket Performance Sample Output

```
        TEST CASE [illegible]      CLO3F+LIH                 REFERENCE CUMMINS P 673
                                                                       BLANK

           3               1             2            1
  1000.
 CLO3F                          -1?.1            3
CL  1.       O    3.      F      1.
 LIH                            -21.6            2
LI  1.       H    1.
```

********** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
LI	HEAT OF FORMATION	38.4100
O	HEAT OF FORMATION	59.5590
F	HEAT OF FORMATION	18.8600
CL	HEAT OF FORMATION	28.9220
HLIO	HEAT OF FORMATION	-57.7000
HLI	HEAT OF FORMATION	32.1000
FHO	HEAT OF FORMATION	-26.1000
CLHO	HEAT OF FORMATION	-21.4000
HO	HEAT OF FORMATION	9.3300
FH	HEAT OF FORMATION	-64.5000
CLH	HEAT OF FORMATION	-21.9700
H2LI2O2	HEAT OF FORMATION	-169.4000
H2O	HEAT OF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
FLIO	HEAT OF FORMATION	-10.0000
CLLIO	HEAT OF FORMATION	-3.4000
LIO	HEAT OF FORMATION	14.0000
FLI	HEAT OF FORMATION	-79.3000
LICL	HEAT OF FORMATION	-46.7780
LI2O	HEAT OF FORMATION	-34.1000
CLFLI2	HEAT OF FORMATION	-180.2000
F2LI2	HEAT OF FORMATION	-213.5000
CL2LI2	HEAT OF FORMATION	-140.8000
(LI)2	HEAT OF FORMATION	50.4000
F3LI3	HEAT OF FORMATION	-357.6000
CL3LI3	HEAT OF FORMATION	-228.3000
FO	HEAT OF FORMATION	32.4000
F2O	HEAT OF FORMATION	7.6000
CLO	HEAT OF FORMATION	24.1920
CL2O	HEAT OF FORMATION	18.1000
CLO2	HEAT OF FORMATION	25.0000
O2	HEAT OF FORMATION	0.
CLFO3	HEAT OF FORMATION	-5.1200
O3	HEAT OF FORMATION	34.0000
CLF	HEAT OF FORMATION	-13.5010
F2	HEAT OF FORMATION	0.
CLF3	HEAT OF FORMATION	-38.7900
CL2	HEAT OF FORMATION	0.

LI	LIQUID	HEAT OF FORMATION	-0.0000
LIJH	COND	HEAT OF FORMATION	-116.6699
LIF	COND	HEAT OF FORMATION	-146.1759
LIGL	LIQUID	HEAT OF FORMATION	-94.4642
LI2O	COND	HEAT OF FORMATION	-143.0486

75 +02 30 +02

AEROSPACE CORPORATION

55 5/14/03
TEST CASE E CLU3F+LIH REFERENCE DUBBINS P 673

COMPONENT	WEIGHT PERCENT	MOLES	MOLE PERCENT
CLU3F	69.999997	1.000000	15.326426
LIH	29.999999	5.524678	84.673574

ELEMENTS	MOLES	MASS BALANCE (MOLES/GM)
H	0.8467	0.37745345E-01
LI	0.8467	0.37745345E-01
C	0.4598	0.20496403E-01
F	0.1533	0.68321345E-02
CL	0.1533	0.68321345E-02

********** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMO DATA LIBRARY [illegible] 5/14/63

TEST CASE [illegible] GLO3F+LIH REFERENCE DORBINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE ONE

THERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE

PRESSURE (PSIA)	[illegible]	961.538	833.333	714.286	574.642	293.919	146.959	97.973
TEMPERATURE (DEG K)	3.04.545	2991.173	2943.379	2893.356	2825.241	2631.960	2454.839	2360.349
H (CAL/GM)	[illegible]	5676.7	5641.6	5604.5	5553.5	5404.7	5263.6	5186.5
S (CAL/GM-DEG K)	[illegible]	2.819	2.819	2.819	2.819	2.819	2.819	2.819
CP (CAL/GM)	[illegible]	1.841	1.857	1.872	1.891	1.927	1.928	1.915
GAMMA	[illegible]	1.152	1.152	1.151	1.149	1.144	1.139	1.136
AVERAGE GAS MOLE WT	[illegible]	23.593	24.059	24.134	24.243	24.609	25.016	25.262
GAS MOLES/100 GM	[illegible]	4.16790	4.15640	4.14361	4.12487	4.06356	3.99745	3.95852
COND MOLES/100 GM	[illegible]	0.43026	[illegible].43655	0.44378	0.45474	0.49273	0.53617	0.56279

COMPOSITION-MOLES PER 100 GRAMS PROPELLANT

H	[illegible].03661	0.03586	0.03324	0.03062	0.02722	0.01877	0.01258	0.00987
LI	[illegible].25515	0.25333	0.24673	0.23935	0.22852	0.19330	0.15616	0.13519
O	[illegible].00014	0.00012	[illegible].00010	0.00008	0.00006	0.00002	0.00001	0.00000
OH	[illegible].00014	[illegible].00013	[illegible].00012	0.00010	0.00008	0.00004	0.00002	0.00001
HLIO	1.24460	1.24453	1.24293	1.24033	1.23511	1.20936	1.17066	1.14312
HLI	[illegible].03703	0.03627	0.03366	0.03101	0.02751	0.01855	0.01187	0.00896
HL	[illegible].00917	0.00499	0.00439	0.00382	0.00313	0.00170	0.00091	0.00063
FH	[illegible].02432	0.02403	0.02302	0.02201	0.02069	0.01733	0.01475	0.01355
CLH	[illegible].01475	[illegible].00465	[illegible].00433	0.00401	0.00360	0.00262	0.00193	0.00163
H2LI2O2	[illegible].00006	0.00006	[illegible].00006	0.00006	0.00006	0.00005	0.00005	0.00005
H2O	[illegible].35027	0.34932	0.34677	0.34427	0.34121	0.33541	0.33513	0.33793
H2	[illegible].86076	0.86271	0.86965	0.87704	0.88737	0.91764	0.94574	0.96041
LIO	[illegible].00434	0.00422	[illegible].00369	0.00318	0.00258	0.00132	0.00065	0.00042
FLI	[illegible].64781	0.64809	[illegible].64967	0.65034	0.65128	0.65430	0.65633	0.65710
LICL	[illegible].67152	0.67164	[illegible].67205	0.67245	0.67296	0.67416	0.67494	0.67524
LI2O	[illegible].01687	[illegible].01603	[illegible].01506	[illegible].01404	[illegible].01267	[illegible].00898	[illegible].00602	0.00466
CLFLI2	[illegible].00332	0.00332	[illegible].00332	[illegible].00332	0.00333	0.00340	0.00352	[illegible].00362
F2LI2	[illegible].00384	0.00384	[illegible].00385	0.00387	0.00390	0.00404	0.00424	0.00440

CL2LI2		.00174	0.00173	0.00170	0.00167	0.00162	0.00150	0.00140	0.00136
ILI12		0.00304	0.00294	0.00262	0.00233	0.00191	0.00102	0.00050	0.00031
F3LI3		0.00003	0.00003	0.00003	0.00003	0.00003	0.00004	0.00005	0.00005
O2		0.00002	0.00002	0.00002	0.00001	0.00001	0.00000	0.00000	0.00000
LI2O	CONV	0.42867	0.43026	0.43655	0.44378	0.45474	0.49273	0.53617	0.56279

********** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMO DATA LIBRARY TAPE 59 5/14/63

TEST CASE 6 CL03F+LIH REFERENCE DOBRINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE ONE

THERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE

PRESSURE (PSIA)	73.483	58.784	48.987	29.392	24.493	20.994	18.370	14.696
TEMPERATURE (DEG K)	2296.899	2249.542	2212.000	2111.911	2077.898	2049.812	2025.959	1987.104
H (CAL/GM)	5133.3	5094.4	5062.9	4976.3	4948.9	4924.7	4904.1	4870.4
S (CAL/GM-DEG K)	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819
CP (CAL/GM)	1.921	1.868	1.826	1.742	1.730	1.720	1.712	1.700
GAMMA	1.134	1.132	1.131	1.128	1.127	1.126	1.125	1.123
AVERAGE GAS MOLE WT	25.439	25.577	25.690	26.007	26.120	26.215	26.298	26.436
GAS MOLES/100 GM	3.93097	3.90977	3.89257	3.84516	3.82852	3.81458	3.80261	3.78278
COND MOLES/100 GM	0.58207	0.59716	0.60957	0.64465	0.65724	0.66794	0.67722	0.69280

COMPOSITION-MOLES PER 100 GRAMS PROPELLANT

H	0.00824	0.00721	0.00643	0.00462	0.00409	0.00369	0.00337	0.00290
LI	0.12092	0.11031	0.10198	0.08047	0.07351	0.06791	0.06330	0.05609
HLIO	1.12151	1.10373	1.08846	1.04256	1.02507	1.00982	0.99628	0.97293
HLI	0.00724	0.00616	0.00535	0.00356	0.00305	0.00268	0.00239	0.00196
HO	0.00049	0.00040	0.00034	0.00021	0.00018	0.00015	0.00014	0.00011
FH	0.01283	0.01232	0.01195	0.01103	0.01076	0.01054	0.01037	0.01010
OLH	0.00145	0.00133	0.00124	0.00102	0.00096	0.00091	0.00087	0.00080
H2LI2O2	0.00005	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004
H2O	0.34183	0.34475	0.34809	0.36006	0.36526	0.37006	0.37450	0.38254
H2	0.98994	0.97692	0.98226	0.99568	0.99991	1.00327	1.00602	1.01028
LIL	0.00031	0.00024	0.00019	0.00011	0.00009	0.00007	0.00006	0.00005
FLI	0.65746	0.65764	0.65773	0.65768	0.65753	0.65738	0.65722	0.65687
LIOL	0.67539	0.67546	0.67551	0.67553	0.67551	0.67548	0.67544	0.67535
LI2O	0.00385	0.00330	0.00290	0.00198	0.00172	0.00152	0.00136	0.00113
CLFLI2	0.00370	0.00378	0.00385	0.00409	0.00418	0.00428	0.00436	0.00451
F2LI2	0.00458	0.00464	0.00474	0.00504	0.00523	0.00536	0.00547	0.00568
CL2LI2	0.00133	0.00132	0.00131	0.00128	0.00128	0.00128	0.00127	0.00127
(LI)2	0.00022	0.00017	0.00014	0.00007	0.00005	0.00004	0.00004	0.00003

F3L13		0.00006	0.00006	0.00007	0.00009	0.00009	0.00010	0.00011	0.00012
L120	CCNC	0.58207	0.59716	0.60957	0.64465	0.65724	0.66794	0.67722	0.69280

********** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMO DATA LIBRARY TAPE 5) 8/14/63

TEST CASE E CL2F+LIH REFERENCE DUBBINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE LAE

THERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE

PRESSURE (PSIA)	9.797	7.348	5.878	2.500	1.250	1.000	0.667	0.500
TEMPERATURE (DEG K)	1919.350	1873.445	1839.055	1716.431	1646.775	1627.521	1593.465	1565.550
H (CAL/GM)	4811.7	4770.6	4741.1	4629.3	4551.9	4527.3	4481.9	4448.7
S (CAL/GM-DEG K)	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819
CP (CAL/GM)	1.783	1.775	1.771	1.776	2.193	2.349	2.586	2.586
GAMMA	1.121	1.119	1.117	1.112	1.101	1.097	1.092	1.091
AVERAGE GAS MOLE WT	26.685	26.661	26.997	27.515	27.350	27.297	27.296	27.470
GAS MOLES/100 GM	3.74747	3.72288	4.70412	3.63443	3.65634	3.66344	3.66375	3.64027
CONDENSED MOLES/100 GM	0.72113	0.74126	0.75687	0.81637	0.79472	0.78818	0.78829	0.80997

COMPOSITION (MOLES PER 100 GRAMS PROPELLANT)

H	.00214	0.00178	0.00151	0.00080	0.00058	0.00054	0.00046	0.00039
LI	.04450	0.03744	0.03260	0.01861	0.01805	0.01808	0.01721	0.01455
HCl	.82+01	0.89583	0.86966	0.76525	0.80686	0.81918	0.81964	0.77898
HLI	.00138	0.00104	0.00084	0.00036	0.00027	0.00024	0.00020	0.00015
H2	.00014	0.00006	0.00005	0.00002	0.00001	0.00001	0.00001	0.00001
FH	.00960	0.00942	0.00924	0.00869	0.00661	0.00610	0.00554	0.00559
CLH	.00071	0.00064	0.00060	0.00046	0.00031	0.	0.00023	0.00022
H2LI2CL2	.00004	0.00004	0.00004	0.00003	0.00003	0.00003	0.00003	0.00003
H2O	.41178	0.41178	0.42248	0.46792	0.44783	0.44211	0.44154	0.46050
H2	1.01703	1.02107	1.02381	1.03163	1.03210	1.03214	1.03269	1.03406
LIO	.00008	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
FLI	.65621	0.65520	0.65447	0.65065	0.65340	0.65458	0.65628	0.65572
LICL	.67518	0.67491	0.67471	0.67370	0.67446	0.67510	0.67543	0.67539
LI2O	.00082	0.00061	0.00050	0.00022	0.00019	0.00018	0.00015	0.00012
CLFLI2	.00482	0.00508	0.00533	0.00634	0.00607	0.00588	0.00556	0.00564
F2LI2	.00612	0.00648	0.00679	0.00823	0.00799	0.00777	0.00741	0.00754
CL2LI2	.00126	0.00129	0.00130	0.00136	0.00119	0.00112	0.00101	0.00098
(LI)2	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000

F3L13		0.00015	0.00018	0.00021	0.00037	0.00038	0.00037	0.00036	0.00039
L120	CCNO	0.72113	0.74126	0.75687	0.81637	0.79472	0.78818	0.78829	0.80997

********** [illegible] EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMO DATA LIBRARY [illegible] 5/14/64

TEST CASE 1 [illegible] REFERENCE DOBBINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE IVC
Co = 5242 FT/SEC

PC/PE	P PSIA	T DEG.-K	H CAL/GM	GAMMA	EPSILON	CF	IS LB-SEC/LB
1.0000	[illegible]	3204.5	5686.52	1.1525	0.	0.	0.
1.0420	959.5395	3191.2	5678.74	1.1523	2.3592	0.1790	29.16
1.2000	833.3333	3143.4	5641.62	1.1515	1.2463	0.3836	62.50
1.4000	714.2857	3093.4	5604.55	1.1506	1.0545	0.5183	84.45
1.7402	574.6416	3025.2	5553.45	1.1492	1.0000	0.6604	107.60
3.4229	293.3139	2832.0	5404.69	1.1444	1.2329	0.9611	156.60
5.8546	170.8594	2654.8	5263.57	1.1392	1.8468	1.1773	191.84
10.2269	97.7723	2360.3	5186.45	1.1361	2.4258	1.2802	208.59
13.6591	73.2202	2296.9	5133.94	1.1341	2.9733	1.3457	219.27
17.5114	57.1341	2249.5	5094.41	1.1325	3.4974	1.3930	226.98
20.4137	48.9967	2212.0	5062.88	1.1312	4.0035	1.4296	232.95
34.2229	29.2122	2111.9	4977.99	1.1276	5.9040	1.5238	248.30
40.8275	24.4933	2077.9	4948.85	1.1266	6.8021	1.5548	253.35
47.6923	20.9742	2049.8	4924.69	1.1256	7.6753	1.5801	257.47
54.4366	18.3703	2026.0	4904.10	1.1247	8.5280	1.6013	260.92
68.0457	14.6960	1987.1	4870.37	1.1233	10.1838	1.6355	266.49
102.0690	9.7973	1919.3	4811.17	1.1207	14.1141	1.6937	275.98
136.0916	7.3480	1873.4	4770.63	1.1189	17.8398	1.7325	282.30
170.1140	5.8784	1839.1	4740.06	1.1174	21.4255	1.7612	286.97
400.0000	2.5000	1716.4	4629.28	1.1120	43.6513	1.8614	303.30
800.0000	1.2500	1646.8	4551.90	1.1010	81.3403	1.9283	314.21
1000.0000	1.0000	1627.5	4527.31	1.0974	99.6364	1.9491	317.59
1500.0000	0.6667	1593.5	4481.92	1.0920	143.5134	1.9869	323.75
2000.0000	0.5000	1565.5	4448.72	1.0906	184.2755	2.0141	328.18

********** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMC DATA LIBRARY TAPE 55 5/14/63

TEST CASE 6 CL03F+LIM REFERENCE DOBBINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE THREE

EPSILON	PC/PE	I OPT	A	E	I EPS	CF OPT	CF EPS
1.0000	1.7401	107.60	93.64	0.16	231.24	0.6603	1.2350
2.0000	7.6865	197.83	42.40	0.33	240.23	1.2141	1.4743
3.0000	13.7742	219.73	35.48	0.49	255.20	1.3485	1.5662
4.0000	20.3900	232.91	31.97	0.65	264.87	1.4294	1.6256
5.0000	27.4158	241.78	29.72	0.81	271.50	1.4838	1.6662
6.0000	34.7390	248.90	28.14	0.98	277.05	1.5275	1.7003
7.0000	42.3537	254.35	26.93	1.14	281.28	1.5610	1.7263
8.0000	50.2048	258.85	25.96	1.30	284.81	1.5886	1.7479
9.0000	58.2631	262.66	25.17	1.47	287.83	1.6120	1.7665
10.0000	66.5140	265.91	24.50	1.63	290.41	1.6319	1.7823
11.0000	74.9123	268.89	23.93	1.79	292.81	1.6502	1.7970
12.0000	83.4671	271.52	23.43	1.96	294.95	1.6664	1.8101
13.0000	92.2297	273.59	22.97	2.12	296.55	1.6790	1.8200
14.0000	101.0540	275.75	22.57	2.28	298.32	1.6923	1.8308
15.0000	110.0025	277.72	22.22	2.44	299.94	1.7044	1.8408
16.0000	119.1211	279.37	21.89	2.61	301.25	1.7145	1.8488
17.0000	128.3039	281.01	21.59	2.77	302.60	1.7246	1.8571
18.0000	137.5844	282.54	21.32	2.93	303.86	1.7340	1.8648
19.0000	146.9623	283.96	21.07	3.10	305.03	1.7427	1.8720
20.0000	156.4862	285.18	20.83	3.26	306.01	1.7502	1.8780
21.0000	166.0322	286.45	20.61	3.42	307.06	1.7580	1.8844
22.0000	175.6443	287.67	20.41	3.58	308.08	1.7655	1.8907
23.0000	185.3228	288.85	20.22	3.75	309.07	1.7727	1.8968
24.0000	195.0674	289.98	20.05	3.91	310.03	1.7796	1.9027
25.0000	204.8782	291.07	19.88	4.07	310.95	1.7863	1.9083

********** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE **********

THERMO DATA LIBRARY TAPE 55 5/14/63

TEST CASE E CL03F+LIM REFERENCE DOBBINS P 673

CHAMBER PRESSURE = 1000 PSIA

TABLE THREE

EPSILON	PC/PE	I OPT	A	M	I EPS	CF OPT	CF EPS
26.0000	214.7553	292.11	19.73	4.24	311.84	1.7927	1.9138
27.0000	224.6986	293.11	19.58	4.40	312.69	1.7989	1.9190
28.0000	234.7182	294.07	19.44	4.56	313.51	1.8047	1.9240
29.0000	244.7839	294.98	19.30	4.73	314.29	1.8103	1.9288
30.0000	254.9259	295.85	19.18	4.89	315.03	1.8157	1.9333
31.0000	265.1341	296.68	19.05	5.05	315.73	1.8207	1.9376
32.0000	275.4085	297.46	18.93	5.21	316.39	1.8255	1.9417
33.0000	285.7459	296.39	18.59	5.38	314.98	1.8190	1.9331
34.0000	299.6277	297.11	18.49	5.54	315.60	1.8234	1.9369
35.0000	309.9886	297.82	18.40	5.70	316.22	1.8278	1.9407
36.0000	321.3585	298.51	18.31	5.87	316.82	1.8320	1.9444
37.0000	332.7374	299.19	18.23	6.03	317.42	1.8361	1.9480
38.0000	341.1254	299.85	18.15	6.19	318.00	1.8402	1.9516
39.0000	351.5222	300.49	18.08	6.35	318.57	1.8442	1.9551
40.0000	361.9281	301.13	18.01	6.52	319.13	1.8480	1.9586
41.0000	372.3431	301.74	17.94	6.68	319.68	1.8518	1.9619
42.0000	382.7671	302.34	17.88	6.84	320.22	1.8555	1.9652
43.0000	393.2000	302.93	17.82	7.01	320.75	1.8591	1.9685
44.0000	403.6421	303.50	17.76	7.17	321.26	1.8626	1.9716
45.0000	414.0930	304.06	17.71	7.33	321.77	1.8660	1.9747
46.0000	424.5531	304.60	17.65	7.50	322.25	1.8694	1.9777
47.0000	435.0222	305.13	17.60	7.66	322.73	1.8726	1.9806
48.0000	445.5001	305.64	17.56	7.82	323.20	1.8757	1.9835
49.0000	455.9871	306.14	17.51	7.98	323.65	1.8788	1.9863
50.0000	466.4832	306.62	17.47	8.15	324.08	1.8818	1.9889

APPENDIX E

Flame Composition Sample Output

```
          TEST CASE E      CLO3F+LIH                  REFERENCE DOBBINS P 673
                                                                     BLANK
                4          2          2           1
  1000.              .00001   4000.       100.       100.         3.
 CLO3F                        -10.1        3
CL    1.      D       3.    F     1.
 LIH                 FUEL     -21.6        2
LI    1.      H       1.
```

********** [illegible] ARE THE FOLLOWING

[illegible]	HEAT OF FORMATION	52.1020
[illegible]	HEAT OF FORMATION	38.4100
[illegible]	HEAT OF FORMATION	59.5590
[illegible]	HEAT OF FORMATION	18.8600
[illegible]	HEAT OF FORMATION	28.9220
[illegible]	HEAT OF FORMATION	-57.7000
[illegible]	HEAT OF FORMATION	32.1000
[illegible]	HEAT OF FORMATION	-26.1000
[illegible]	HEAT OF FORMATION	-21.4000
[illegible]	HEAT OF FORMATION	9.3300
[illegible]	HEAT OF FORMATION	-64.5000
[illegible]	HEAT OF FORMATION	-21.9700
[illegible]	HEAT OF FORMATION	-169.4000
[illegible]	HEAT OF FORMATION	-57.7980
[illegible]	HEAT OF FORMATION	0.
[illegible]	HEAT OF FORMATION	-10.0000
[illegible]	HEAT OF FORMATION	-3.4000
[illegible]	HEAT OF FORMATION	14.0000
[illegible]	HEAT OF FORMATION	-79.3000
[illegible]	HEAT OF FORMATION	-46.7780
[illegible]	HEAT OF FORMATION	-34.1000
CLFCL2	HEAT OF FORMATION	-180.2000
F2CL2	HEAT OF FORMATION	-213.5000
CL2CL2	HEAT OF FORMATION	-140.8000
[illegible]	HEAT OF FORMATION	50.4000
[illegible]	HEAT OF FORMATION	-357.6000
CL3CL3	HEAT OF FORMATION	-228.3000
[illegible]	HEAT OF FORMATION	32.4000
[illegible]	HEAT OF FORMATION	7.6000
[illegible]	HEAT OF FORMATION	24.1920
[illegible]	HEAT OF FORMATION	18.1000
[illegible]	HEAT OF FORMATION	25.3000
[illegible]	HEAT OF FORMATION	0.
CLF03	HEAT OF FORMATION	-5.1200
[illegible]	HEAT OF FORMATION	34.0000
[illegible]	HEAT OF FORMATION	-13.5010
[illegible]	HEAT OF FORMATION	0.
CLF3	HEAT OF FORMATION	-38.7900
CL2	HEAT OF FORMATION	0.

LI	LIQUID	HEAT OF FORMATION	-0.0003
LIH	COND	HEAT OF FORMATION	-116.6699
LIF	COND	HEAT OF FORMATION	-146.1759
LICL	LIQUID	HEAT OF FORMATION	-94.4642
LI2O	COND	HEAT OF FORMATION	-143.0486

23333333+C1

AEROSPACE CORPORATION

55 5/14/63

TEST CASE [illegible] REFERENCE DUBBINS P 673

FUEL COMPONENT LIH FUEL
OXIDIZER COMPONENT CLO3F

MIXTURE RATIO 2.33333 OXIDIZER RATIO 5.72402

SYSTEM ELEMENTS	FUEL FORMULA	OXIDIZER FORMULA	MASS BALANCE (MOLES/SYSTEM-GM)
H	1.00000	0.	0.37745346E-01
LI	1.00000	0.	0.37745346E-01
O	0.	3.00000	0.20496403E-01
F	0.	1.00000	0.68321343E-02
CL	0.	1.00000	0.68321343E-02

FLAME COMPOSITION, OPTION SELECTED,UNHEATED SYSTEM ENTHALPY (KCAL/GM)= 5.68651

AEROSPACE CORPORATION
FLAME TEMPERATURE SOLUTION

TAPE [illegible]
[illegible]

REFERENCE DOBBINS P 673

PRESSURE(PSIA) 1000.000404
TEMPERATURE(DEG-K) 3004.544220
ENTHALPY(KCAL/GM) 5.686518
ENTROPY(CAL/GM-DEG K) 2.819029
AVERAGE GAS CP 0.438356
AVERAGE GAS MOLE WEIGHT 23.975375

PRODUCT	MOLES	MOLE FRACTION	CP	H	S	H-TS
H	[illegible]	[illegible]	4.96860	100.26797	38.86952	-16.51721
LI	[illegible]	[illegible]	5.21120	183.59177	44.65989	49.40917
C	0.131205E-05	0.283252E-04	5.00427	75.15919	50.10357	-75.37921
F	[illegible]	0.158699E-05	4.98395	64.09747	49.79854	-85.52445
CL	[illegible]	[illegible]	5.03386	47.97132	51.63062	-107.15515
HLIO	[illegible]	[illegible]	13.33445	143.14154	78.17118	-91.72723
HLI	[illegible]	[illegible]	9.50614	222.41169	60.26639	41.33867
FHO	[illegible]	[illegible]	13.37936	74.93647	79.96225	-165.31364
CLHO	[illegible]	[illegible]	13.40027	53.38119	82.69428	-195.07743
HO	[illegible]	[illegible]	8.77953	67.54974	61.39529	-116.91511
FH	[illegible]	[illegible]	8.66368	22.84359	58.70911	-153.55053
CLH	[illegible]	[illegible]	8.90318	39.65330	62.37747	-147.76257
H2LI2+	[illegible]	[illegible]	30.51032	240.14353	115.32018	-106.34103
H2O	[illegible]	[illegible]	13.30718	43.95971	68.44114	-161.67471
H2	0.960756E-02	0.187137E-00	8.86136	90.69106	48.47841	-54.96446
FLIO	[illegible]	0.242136E-10	13.81927	191.04716	88.01992	-73.41256
CLLIO	[illegible]	0.135107E-08	13.83323	171.36386	90.81194	-101.48462
LIO	[illegible]	[illegible]	9.08850	171.05684	69.71476	-38.40421
FLI	[illegible]	0.140840E-00	9.32073	108.03727	67.78611	-95.62908
LICL	[illegible]	0.145494E-00	9.33868	114.30698	71.26413	-99.80925
LI2O	0.162973E-03	0.354311E-02	13.81327	266.90541	84.94691	11.67868
CLFLI2	0.331763E-04	0.721282E-03	19.79427	171.63141	106.93296	-149.65339
F2LI2	0.383652E-04	0.834094E-03	19.77527	164.44770	103.51093	-146.55546
CL2LI2	0.174456E-04	0.379282E-03	19.82314	185.25118	111.44200	-149.78124
(LI)2	0.303779E-04	0.660443E-03	9.91045	339.19423	68.36500	133.78857
F3LI3	[illegible]	[illegible]	31.59259	213.59632	137.25882	-198.80385
CL3LI3	0.289343E-09	0.629058E-07	31.68932	265.11765	149.25496	-183.32548

FO		0.2116883E-12	0.4652194E-11	8.90614	89.46574	70.20648	-121.47273
F2L		0.	0.	13.84418	108.94000	88.88195	-158.10975
CLO		0.2393351E-13	0.5116756E-CB	9.24559	55.34491	74.10799	-167.31582
CL2O		0.2571795E-12	0.5589953E-15	13.85414	66.57530	93.73197	-215.04654
CLO2		0.6672994E-15	0.1450777E-13	14.34505	70.75253	91.15571	-203.12882
O2		0.2154.8E-06	0.4683316E-05	9.55304	27.60031	67.98746	-176.67101
CLFO3		0.	0.	25.59368	102.82192	118.75474	-253.98193
L3		0.3766491E-14	0.8184851E-13	13.80503	75.72202	85.81112	-182.10128
CLF		0.3463856E-11	0.7574202E-10	9.28609	47.19747	72.14205	-169.55652
F2		0.1314396E-14	0.2857592E-13	9.53505	87.53697	68.58443	-118.52598
CLF3		0.	0.	19.80918	113.10093	111.35698	-221.47604
CL2		0.3438693E-11	0.7472146E-10	9.37532	34.46850	73.77419	-187.18931
LI	LIQUID	0.	0.	6.65145	150.02692	24.34957	77.76894
LICH	GCNO	0.	0.	20.74000	110.47824	59.22739	-67.47307
LIF	GCNO	0.	0.	15.31000	62.80357	45.65457	-74.36762
LICL	LIQUID	0.	0.	14.40000	81.14043	49.36796	-67.18778
LI2O	GCNO	0.4286172E-02	0.9319972E-01	23.00000	193.04751	62.99744	3.76894

APPENDIX F

Mollier Diagram Sample Output

TEST CASE [illegible] REFERENCE DOBBINS P 673

BLANK

	4		2			1		
1000.		.000.1	4000.		100.	100.	1.	
CL03F			-10.1		5			
CL 1.	C	2.	F 1.					
LIH		FUEL	-21.6		2			
LI 1.	H	1.						

********** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
LI	HEAT OF FORMATION	38.4100
O	HEAT OF FORMATION	59.5590
F	HEAT OF FORMATION	18.8600
CL	HEAT OF FORMATION	28.9220
HLIO	HEAT OF FORMATION	-57.7000
HLI	HEAT OF FORMATION	32.1000
FLO	HEAT OF FORMATION	-26.1000
CLHO	HEAT OF FORMATION	-21.4000
HO	HEAT OF FORMATION	9.3300
FH	HEAT OF FORMATION	-64.5000
CLH	HEAT OF FORMATION	-21.9700
H2LI2O2	HEAT OF FORMATION	-169.4000
H2O	HEAT OF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
FLIO	HEAT OF FORMATION	-10.0000
CLLIO	HEAT OF FORMATION	-3.4000
LIO	HEAT OF FORMATION	14.0000
FLI	HEAT OF FORMATION	-79.3000
LICL	HEAT OF FORMATION	-46.7780
LI2O	HEAT OF FORMATION	-34.1000
CLFLI2	HEAT OF FORMATION	-180.2000
F2LI2	HEAT OF FORMATION	-213.5000
CL2LI2	HEAT OF FORMATION	-140.8000
(LI)2	HEAT OF FORMATION	50.4000
F3LI3	HEAT OF FORMATION	-357.6000
CL3LI3	HEAT OF FORMATION	-228.3000
FL	HEAT OF FORMATION	32.4000
F2O	HEAT OF FORMATION	7.6000
CLO	HEAT OF FORMATION	24.1920
CL2O	HEAT OF FORMATION	18.1000
CLO2	HEAT OF FORMATION	25.0000
O2	HEAT OF FORMATION	0.
CLFO3	HEAT OF FORMATION	-5.1200
O3	HEAT OF FORMATION	34.0000
CLF	HEAT OF FORMATION	-13.5010
F2	HEAT OF FORMATION	0.
CLF3	HEAT OF FORMATION	-38.7900
CL2	HEAT OF FORMATION	0.

LI	LIQUID	HEAT OF FORMATION	-0.0000
LI2	COND	HEAT OF FORMATION	-116.6699
LI	COND	HEAT OF FORMATION	-146.1759
LI2L	LIQUID	HEAT OF FORMATION	-94.4642
LI2O	COND	HEAT OF FORMATION	-143.0486

23333333+01

AEROSPACE CORPORATION

55 5/14/63
TEST CASE 8 CLC3F+LIH REFERENCE DOBBINS P 673

FUEL COMPONENT LIH FUEL
OXIDIZER COMPONENT CLC3F

MIXTURE RATIO 2.33333 OXIDIZER RATIO 0.72402

SYSTEM ELEMENTS	FUEL FORMULA	OXIDIZER FORMULA	MASS BALANCE (MOLES/SYSTEM-GM)
H	1.00000	0.	0.37745346E-01
LI	1.00000	0.	0.37745346E-01
C	0.	3.00000	0.20496403E-01
F	0.	1.00000	0.68321343E-02
CL	0.	1.00000	0.68321343E-02

```
MOLLIER [illegible] DESIRED SYSTEM ENTHALPY (KCAL/GM)=     5.68651
P(PSIA)=  0.10000E 04 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 3.2451 H(KCAL/GM)=   7.1588 RHO(GM/CU-CM)=0.339910E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 3.1994 H(KCAL/GM)=   6.9783 RHO(GM/CU-CM)=0.406640E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 3.1580 H(KCAL/GM)=   6.8188 RHO(GM/CU-CM)=0.427266E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 3.1205 H(KCAL/GM)=   6.6780 RHO(GM/CU-CM)=0.445806E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 3.0862 H(KCAL/GM)=   6.5531 RHO(GM/CU-CM)=0.464383E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 3.0544 H(KCAL/GM)=   6.4414 RHO(GM/CU-CM)=0.481300E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 3.0255 H(KCAL/GM)=   6.3405 RHO(GM/CU-CM)=0.502210E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 2.9980 H(KCAL/GM)=   6.2480 RHO(GM/CU-CM)=0.521824E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 2.9716 H(KCAL/GM)=   6.1623 RHO(GM/CU-CM)=0.542149E-02
P(PSIA)=  0.10000E 04 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 2.8810 H(KCAL/GM)=   5.8758 RHO(GM/CU-CM)=0.608619E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 2.8163 H(KCAL/GM)=   5.6782 RHO(GM/CU-CM)=0.664214E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 2.7590 H(KCAL/GM)=   5.5033 RHO(GM/CU-CM)=0.719334E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 2.7077 H(KCAL/GM)=   5.3630 RHO(GM/CU-CM)=0.774241E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 2.6606 H(KCAL/GM)=   5.2335 RHO(GM/CU-CM)=0.829635E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 2.6163 H(KCAL/GM)=   5.1153 RHO(GM/CU-CM)=0.886851E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 2.5218 H(KCAL/GM)=   4.8740 RHO(GM/CU-CM)=0.102507E-01
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 2.4531 H(KCAL/GM)=   4.7059 RHO(GM/CU-CM)=0.114142E-01
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 2.3933 H(KCAL/GM)=   4.5651 RHO(GM/CU-CM)=0.125406E-01
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 2.3389 H(KCAL/GM)=   4.4427 RHO(GM/CU-CM)=0.136552E-01
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 2.2335 H(KCAL/GM)=   4.2274 RHO(GM/CU-CM)=0.175502E-01
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 04 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 2.1112 H(KCAL/GM)=   3.9645 RHO(GM/CU-CM)=0.248345E-01
          LIOH     COND   PRESENT
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          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 2.0253 H(KCAL/GM)=  3.7967 RHO(GM/CU-CM)=0.316314E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1650.00 S(CAL/GM-DEG)= 1.9599 H(KCAL/GM)=  3.6755 RHO(GM/CU-CM)=0.374531E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 1.9033 H(KCAL/GM)=  3.5765 RHO(GM/CU-CM)=0.425513E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 1.8170 H(KCAL/GM)=  3.4393 RHO(GM/CU-CM)=0.475886E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 1.7668 H(KCAL/GM)=  3.3615 RHO(GM/CU-CM)=0.516456E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 1.7153 H(KCAL/GM)=  3.2868 RHO(GM/CU-CM)=0.559113E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 1.6612 H(KCAL/GM)=  3.2139 RHO(GM/CU-CM)=0.606030E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 1.6037 H(KCAL/GM)=  3.1420 RHO(GM/CU-CM)=0.659314E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
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          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100[illegible]E 04 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 1.5523 H(KCAL/GM)=  3.0266 RHO(GM/CU-CM)=0.721272E-01
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100[illegible]E 04 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 1.4354 H(KCAL/GM)=  2.9563 RHO(GM/CU-CM)=0.734803E-01
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 1.3605 H(KCAL/GM)=  2.8854 RHO(GM/CU-CM)=0.883971E-01
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.2737 H(KCAL/GM)=  2.8168 RHO(GM/CU-CM)=0.994896E-01
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 1.0797 H(KCAL/GM)=  2.6674 RHO(GM/CU-CM)=0.113716E-00
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 0.9862 H(KCAL/GM)=  2.6067 RHO(GM/CU-CM)=0.132674E-00
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 0.8800 H(KCAL/GM)=  2.5484 RHO(GM/CU-CM)=0.159208E-00
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
          LI2O  COND    PRESENT
P(PSIA)=  0.100000E 04 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 0.7565 H(KCAL/GM)=  2.4931 RHO(GM/CU-CM)=0.199011E-00
          LIOH  COND    PRESENT
          LIF   COND    PRESENT
          LICL  LIQUID  PRESENT
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          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 04 T(DEG-K)=  300.00 S(CAL/GM-DEG)= 0.6092 H(KCAL/GM)=   2.4418 RHO(GM/CU-CM)=0.265347E-00
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL   LIQUID   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 04 T(DEG-K)=  200.00 S(CAL/GM-DEG)= 0.3559 H(KCAL/GM)=   2.4063 RHO(GM/CU-CM)=0.398021E-00
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL   LIQUID   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 04 T(DEG-K)=  100.00 S(CAL/GM-DEG)= 0.1972 H(KCAL/GM)=   2.3784 RHO(GM/CU-CM)=0.796042E 00
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL   LIQUID   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 03 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 3.9381 H(KCAL/GM)=   8.8383 RHO(GM/CU-CM)=0.301780E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 3.8304 H(KCAL/GM)=   8.4128 RHO(GM/CU-CM)=0.325293E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 3.7257 H(KCAL/GM)=   8.0095 RHO(GM/CU-CM)=0.350697E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 3.6243 H(KCAL/GM)=   7.6291 RHO(GM/CU-CM)=0.377468E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 3.5264 H(KCAL/GM)=   7.3088 RHO(GM/CU-CM)=0.404996E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 3.4320 H(KCAL/GM)=   7.0231 RHO(GM/CU-CM)=0.432580E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 3.3413 H(KCAL/GM)=   6.7827 RHO(GM/CU-CM)=0.459623E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 3.2543 H(KCAL/GM)=   6.5839 RHO(GM/CU-CM)=0.485856E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 3.1709 H(KCAL/GM)=   6.4202 RHO(GM/CU-CM)=0.511331E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 3.0911 H(KCAL/GM)=   6.2838 RHO(GM/CU-CM)=0.536385E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 3.0152 H(KCAL/GM)=   6.1672 RHO(GM/CU-CM)=0.561503E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 2.9431 H(KCAL/GM)=   6.0648 RHO(GM/CU-CM)=0.587138E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 3.1282 H(KCAL/GM)=   5.9728 RHO(GM/CU-CM)=0.613671E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 3.0974 H(KCAL/GM)=   5.8881 RHO(GM/CU-CM)=0.641469E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 3.0676 H(KCAL/GM)=   5.8092 RHO(GM/CU-CM)=0.670856E-03
P(PSIA)=  0.1000E 03 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 2.9468 H(KCAL/GM)=   5.5065 RHO(GM/CU-CM)=0.762122E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 03 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 2.8486 H(KCAL/GM)=   5.2606 RHO(GM/CU-CM)=0.854460E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 03 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 2.7697 H(KCAL/GM)=   5.0751 RHO(GM/CU-CM)=0.941282E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 03 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 2.7024 H(KCAL/GM)=   4.9235 RHO(GM/CU-CM)=0.102692E-02
          LI2O     COND   PRESENT
P(PSIA)=  0.1000E 03 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 2.6395 H(KCAL/GM)=   4.7885 RHO(GM/CU-CM)=0.111670E-02
          LI2O     COND   PRESENT
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P(PSIA)=  0.10000E 03 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 2.4912 H(KCAL/GM)=  4.4630 RHO(GM/CU-CM)=0.135055E-02
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 2.3961 H(KCAL/GM)=  4.2975 RHO(GM/CU-CM)=0.153716E-02
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 2.3206 H(KCAL/GM)=  4.1575 RHO(GM/CU-CM)=0.170879E-02
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 2.2540 H(KCAL/GM)=  4.0410 RHO(GM/CU-CM)=0.187950E-02
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 2.0453 H(KCAL/GM)=  3.7134 RHO(GM/CU-CM)=0.223876E-02
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 1.8707 H(KCAL/GM)=  3.4370 RHO(GM/CU-CM)=0.388313E-02
          LIOH    COND  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 1.7916 H(KCAL/GM)=  3.3221 RHO(GM/CU-CM)=0.473715E-02
          LIOH    COND  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 1.7249 H(KCAL/GM)=  3.2320 RHO(GM/CU-CM)=0.549237E-02
          LIOH    COND  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 1.6607 H(KCAL/GM)=  3.1516 RHO(GM/CU-CM)=0.622823E-02
          LIOH    COND  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 1.5553 H(KCAL/GM)=  3.0318 RHO(GM/CU-CM)=0.699647E-02
          LIOH    COND  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
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P(PSIA)=  0.100000E 03 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 1.4858 H(KCAL/GM)=  2.9588 RHO(GM/CU-CM)=0.783653E-02
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 1.4095 H(KCAL/GM)=  2.8865 RHO(GM/CU-CM)=0.879289E-02
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.3278 H(KCAL/GM)=  2.8171 RHO(GM/CU-CM)=0.993482E-02
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 1.1274 H(KCAL/GM)=  2.6674 RHO(GM/CU-CM)=0.113701E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 1.0338 H(KCAL/GM)=  2.6067 RHO(GM/CU-CM)=0.132673E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 0.9277 H(KCAL/GM)=  2.5484 RHO(GM/CU-CM)=0.159208E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 0.8042 H(KCAL/GM)=  2.4931 RHO(GM/CU-CM)=0.199011E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 300.00 S(CAL/GM-DEG)= 0.6569 H(KCAL/GM)=  2.4418 RHO(GM/CU-CM)=0.265348E-01
          LIOH     COND  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 03 T(DEG-K)= 200.00 S(CAL/GM-DEG)= 0.4035 H(KCAL/GM)=  2.4063 RHO(GM/CU-CM)=0.398021E-01
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          LICH     COND   PRESENT
          LIF      COND   PRESENT
          LICL   LIQUID   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 03 T(DEG-K)= 100.00 S(CAL/GM-DEG)= 0.2449 H(KCAL/GM)=   2.3784 RHO(GM/CU-CM)=0.796042E-01
          LICH     COND   PRESENT
          LIF      COND   PRESENT
          LICL   LIQUID   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 4.3325 H(KCAL/GM)=  11.3429 RHO(GM/CU-CM)=0.226936E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 4.8327 H(KCAL/GM)=  10.9486 RHO(GM/CU-CM)=0.240611E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 4.7169 H(KCAL/GM)=  10.5029 RHO(GM/CU-CM)=0.257020E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 4.5843 H(KCAL/GM)=  10.0056 RHO(GM/CU-CM)=0.276824E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 4.4362 H(KCAL/GM)=   9.4652 RHO(GM/CU-CM)=0.300655E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 4.2772 H(KCAL/GM)=   8.9011 RHO(GM/CU-CM)=0.328886E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 4.1146 H(KCAL/GM)=   8.3406 RHO(GM/CU-CM)=0.361450E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 3.9574 H(KCAL/GM)=   7.8129 RHO(GM/CU-CM)=0.397685E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 3.8125 H(KCAL/GM)=   7.3423 RHO(GM/CU-CM)=0.436273E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 3.6868 H(KCAL/GM)=   6.9460 RHO(GM/CU-CM)=0.475467E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 3.5831 H(KCAL/GM)=   6.6298 RHO(GM/CU-CM)=0.513495E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 3.5013 H(KCAL/GM)=   6.3882 RHO(GM/CU-CM)=0.549246E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 3.4374 H(KCAL/GM)=   6.2058 RHO(GM/CU-CM)=0.582840E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 3.3857 H(KCAL/GM)=   6.0635 RHO(GM/CU-CM)=0.615369E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 3.3413 H(KCAL/GM)=   5.9458 RHO(GM/CU-CM)=0.648016E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 3.3014 H(KCAL/GM)=   5.8441 RHO(GM/CU-CM)=0.681706E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 3.2641 H(KCAL/GM)=   5.7528 RHO(GM/CU-CM)=0.717095E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 3.2284 H(KCAL/GM)=   5.6689 RHO(GM/CU-CM)=0.754708E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 3.1936 H(KCAL/GM)=   5.5906 RHO(GM/CU-CM)=0.795022E-04
P(PSIA)=  0.10000E 02 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 3.0328 H(KCAL/GM)=   5.2466 RHO(GM/CU-CM)=0.922256E-04
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 2.8969 H(KCAL/GM)=   4.9668 RHO(GM/CU-CM)=0.105574E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 2.7985 H(KCAL/GM)=   4.7748 RHO(GM/CU-CM)=0.117794E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 2.7117 H(KCAL/GM)=   4.6142 RHO(GM/CU-CM)=0.130440E-03
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 2.5184 H(KCAL/GM)=   4.2761 RHO(GM/CU-CM)=0.161399E-03
          LIF      COND   PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 2.3064 H(KCAL/GM)=   3.9400 RHO(GM/CU-CM)=0.187175E-03
          LIF      COND   PRESENT
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          LI2O     COND  PRESENT
P(PSIA)=  0.1000[illegible] 02 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 2.2045 H(KCAL/GM)=  3.7819 RHO(GM/CU-CM)=0.211404E-03
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 2.1207 H(KCAL/GM)=  3.6603 RHO(GM/CU-CM)=0.235784E-03
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 1.9362 H(KCAL/GM)=  3.4108 RHO(GM/CU-CM)=0.307412E-03
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 1.8370 H(KCAL/GM)=  3.2864 RHO(GM/CU-CM)=0.357472E-03
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 1.7293 H(KCAL/GM)=  3.1635 RHO(GM/CU-CM)=0.397530E-03
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 1.5665 H(KCAL/GM)=  2.9688 RHO(GM/CU-CM)=0.672121E-03
          LIGH     COND  PRESENT
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 1.4702 H(KCAL/GM)=  2.8973 RHO(GM/CU-CM)=0.832465E-03
          LIGH     COND  PRESENT
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.3794 H(KCAL/GM)=  2.8200 RHO(GM/CU-CM)=0.979341E-03
          LIGH     COND  PRESENT
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 1.1758 H(KCAL/GM)=  2.6679 RHO(GM/CU-CM)=0.113526E-02
          LIGH     COND  PRESENT
          LIF      COND  PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E 02 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 1.0815 H(KCAL/GM)=  2.6068 RHO(GM/CU-CM)=0.132668E-02
          LIGH     COND  PRESENT
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          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible] 02 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 0.9753 H(KCAL/GM)=  2.5484 RHO(GM/CU-CM)=0.159298E-02
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible] 02 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 0.[illegible] H(KCAL/GM)=  2.4931 RHO(GM/CU-CM)=0.199011E-02
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible] 02 T(DEG-K)= 300.00 S(CAL/GM-DEG)= 0.7046 H(KCAL/GM)=  2.4420 RHO(GM/CU-CM)=0.265346E-02
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.4[illegible] 02 T(DEG-K)= 200.00 S(CAL/GM-DEG)= 0.5944 H(KCAL/GM)=  3.1523 RHO(GM/CU-CM)=0.107314E-01
          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.[illegible] 02 T(DEG-K)= 100.00 S(CAL/GM-DEG)= 0.2920 H(KCAL/GM)=  2.3799 RHO(GM/CU-CM)=0.796024E-02
          LIOH     COND   PRESENT
          LIF      COND   PRESENT
          LICL     LIQUID PRESENT
          LI2O     COND   PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 5.7318 H(KCAL/GM)= 12.7431 RHO(GM/CU-CM)=0.200696E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 5.6719 H(KCAL/GM)= 12.5064 RHO(GM/CU-CM)=0.208711E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 5.6054 H(KCAL/GM)= 12.2507 RHO(GM/CU-CM)=0.217656E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 5.5302 H(KCAL/GM)= 11.9686 RHO(GM/CU-CM)=0.227818E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 5.4422 H(KCAL/GM)= 11.6475 RHO(GM/CU-CM)=0.239665E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 5.3360 H(KCAL/GM)= 11.2707 RHO(GM/CU-CM)=0.253892E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 5.2050 H(KCAL/GM)= 10.8130 RHO(GM/CU-CM)=0.271514E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 5.0433 H(KCAL/GM)= 10.2775 RHO(GM/CU-CM)=0.293855E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 4.8489 H(KCAL/GM)=  9.6461 RHO(GM/CU-CM)=0.322417E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 4.6285 H(KCAL/GM)=  8.9516 RHO(GM/CU-CM)=0.358371E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 4.3969 H(KCAL/GM)=  8.2456 RHO(GM/CU-CM)=0.401891E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 4.1744 H(KCAL/GM)=  7.5871 RHO(GM/CU-CM)=0.451646E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 3.9782 H(KCAL/GM)=  7.0295 RHO(GM/CU-CM)=0.504750E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 3.8195 H(KCAL/GM)=  6.5929 RHO(GM/CU-CM)=0.557228E-05
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P(PSIA)=  0.100000E 01 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 3.7020 H(KCAL/GM)=  6.2912 RHO(GM/CU-CM)=0.605506E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 3.6184 H(KCAL/GM)=  6.0687 RHO(GM/CU-CM)=0.648963E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 3.5364 H(KCAL/GM)=  5.9158 RHO(GM/CU-CM)=0.690033E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 3.4547 H(KCAL/GM)=  5.7942 RHO(GM/CU-CM)=0.731333E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 3.4562 H(KCAL/GM)=  5.6896 RHO(GM/CU-CM)=0.774480E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 3.4146 H(KCAL/GM)=  5.5957 RHO(GM/CU-CM)=0.820426E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 3.3726 H(KCAL/GM)=  5.5036 RHO(GM/CU-CM)=0.869860E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 3.3318 H(KCAL/GM)=  5.4301 RHO(GM/CU-CM)=0.923405E-05
P(PSIA)=  0.100000E 01 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 3.0967 H(KCAL/GM)=  4.9989 RHO(GM/CU-CM)=0.111446E-04
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 2.9360 H(KCAL/GM)=  4.7172 RHO(GM/CU-CM)=0.128708E-04
          LI2O     COND  PRESENT
P(PSIA)=  0.100001E 01 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 2.7662 H(KCAL/GM)=  4.4441 RHO(GM/CU-CM)=0.143711E-04
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 2.5121 H(KCAL/GM)=  4.0527 RHO(GM/CU-CM)=0.180163E-04
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 2.3184 H(KCAL/GM)=  3.7711 RHO(GM/CU-CM)=0.218894E-04
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 2.2113 H(KCAL/GM)=  3.6265 RHO(GM/CU-CM)=0.248348E-04
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 2.1003 H(KCAL/GM)=  3.5120 RHO(GM/CU-CM)=0.280217E-04
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 1.8442 H(KCAL/GM)=  3.1996 RHO(GM/CU-CM)=0.381126E-04
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 1.7592 H(KCAL/GM)=  3.1038 RHO(GM/CU-CM)=0.436526E-04
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 1.6914 H(KCAL/GM)=  3.0393 RHO(GM/CU-CM)=0.487914E-04
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E 01 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.4736 H(KCAL/GM)=  2.8547 RHO(GM/CU-CM)=0.837930E-04
          LICM     COND  PRESENT
          LIF      COND  PRESENT
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LIQL LI.[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 1.2320 H(KCAL/GM)= 2.6735 RHO(GM/CU-CM)=0.111777E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 1.1294 H(KCAL/GM)= 2.6069 RHO(GM/CU-CM)=0.132617E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 1.0230 H(KCAL/GM)= 2.5484 RHO(GM/CU-CM)=0.159208E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.8995 H(KCAL/GM)= 2.4932 RHO(GM/CU-CM)=0.199008E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.7523 H(KCAL/GM)= 2.4419 RHO(GM/CU-CM)=0.265312E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.4944 H(KCAL/GM)= 2.4063 RHO(GM/CU-CM)=0.396021E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.3402 H(KCAL/GM)= 2.3785 RHO(GM/CU-CM)=0.796042E-03
LIOH [illegible] PRESENT
LIF [illegible] PRESENT
LIQL LI[illegible] PRESENT
LI2O [illegible] PRESENT
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 6.3952 H(KCAL/GM)= 13.4116 RHO(GM/CU-CM)=0.191272E-06
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 6.3513 H(KCAL/GM)= 13.2775 RHO(GM/CU-CM)=0.197196E-06
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 6.3091 H(KCAL/GM)= 13.1154 RHO(GM/CU-CM)=0.203846E-06
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 6.2576 H(KCAL/GM)= 12.9221 RHO(GM/CU-CM)=0.211351E-06

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P(PSIA)=  0.1000[illegible]E-[illegible] T([illegible]-K)=9[illegible] S(CAL/GM-DEG)= 6.1969 H(KCAL/GM)= 12.7006 RHO(GM/CU-CM)=0.219790E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 6.1285 H(KCAL/GM)= 12.4579 RHO(GM/CU-CM)=0.229194E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 6.0532 H(KCAL/GM)= 12.1943 RHO(GM/CU-CM)=0.239666E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 5.9685 H(KCAL/GM)= 11.9145 RHO(GM/CU-CM)=0.251549E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=3200.00 S(CAL/GM-DEG)= 5.8672 H(KCAL/GM)= 11.5855 RHO(GM/CU-CM)=0.265573E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=3100.00 S(CAL/GM-DEG)= 5.7382 H(KCAL/GM)= 11.1795 RHO(GM/CU-CM)=0.282964E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=3000.00 S(CAL/GM-DEG)= 5.5674 H(KCAL/GM)= 10.6590 RHO(GM/CU-CM)=0.305630E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 5.3416 H(KCAL/GM)= 9.9732 RHO(GM/CU-CM)=0.336295E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=2[illegible] S(CAL/GM-DEG)= 5.0597 H(KCAL/GM)= 9.1402 RHO(GM/CU-CM)=0.377930E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 4.7461 H(KCAL/GM)= 8.3279 RHO(GM/CU-CM)=0.431800E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=2[illegible] S(CAL/GM-DEG)= 4.4411 H(KCAL/GM)= 7.5194 RHO(GM/CU-CM)=0.496046E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 4.1796 H(KCAL/GM)= 6.8521 RHO(GM/CU-CM)=0.565545E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.9515 H(KCAL/GM)= 6.3662 RHO(GM/CU-CM)=0.632885E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.8505 H(KCAL/GM)= 6.0577 RHO(GM/CU-CM)=0.691700E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.7556 H(KCAL/GM)= 5.7665 RHO(GM/CU-CM)=0.743476E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.7018 H(KCAL/GM)= 5.7291 RHO(GM/CU-CM)=0.794042E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.6449 H(KCAL/GM)= 5.6124 RHO(GM/CU-CM)=0.846929E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=1[illegible] S(CAL/GM-DEG)= 3.5923 H(KCAL/GM)= 5.5100 RHO(GM/CU-CM)=0.903710E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=1[illegible] S(CAL/GM-DEG)= 3.5420 H(KCAL/GM)= 5.4170 RHO(GM/CU-CM)=0.965277E-06
P(PSIA)=  0.1[illegible] T([illegible]-K)=[illegible] S(CAL/GM-DEG)= 3.4934 H(KCAL/GM)= 5.3326 RHO(GM/CU-CM)=0.103237E-05
P(PSIA)=  0.1[illegible] T([illegible]-K)=1[illegible] S(CAL/GM-DEG)= 3.2395 H(KCAL/GM)= 4.7194 RHO(GM/CU-CM)=0.122245E-05
          LIF[illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1500.00 S(CAL/GM-DEG)= 2.9657 H(KCAL/GM)= 4.4924 RHO(GM/CU-CM)=0.147509E-05
          LI2[illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1400.00 S(CAL/GM-DEG)= 2.7782 H(KCAL/GM)= 4.2201 RHO(GM/CU-CM)=0.171271E-05
          LI2[illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1300.00 S(CAL/GM-DEG)= 2.4469 H(KCAL/GM)= 3.7735 RHO(GM/CU-CM)=0.226444E-05
          LIF     [illegible] PRESENT
          LI2O    [illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1200.00 S(CAL/GM-DEG)= 2.2930 H(KCAL/GM)= 3.5801 RHO(GM/CU-CM)=0.266030E-05
          LIF     [illegible] PRESENT
          LI2O    [illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1100.00 S(CAL/GM-DEG)= 2.1543 H(KCAL/GM)= 3.4216 RHO(GM/CU-CM)=0.302239E-05
          LIF     [illegible] PRESENT
          LI2O    [illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)=1000.00 S(CAL/GM-DEG)= 1.8982 H(KCAL/GM)= 3.1541 RHO(GM/CU-CM)=0.411310E-05
          LIF     [illegible] PRESENT
          LIOL    LIQUID PRESENT
          LI2O    [illegible] PRESENT
P(PSIA)=  0.1[illegible] T([illegible]-K)= 900.00 S(CAL/GM-DEG)= 1.7827 H(KCAL/GM)= 3.0435 RHO(GM/CU-CM)=0.485428E-05
          LIF     [illegible] PRESENT
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           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.7093 H(KCAL/GM)=  2.9811 RHO(GM/CU-CM)=0.549076E-05
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 1.3673 H(KCAL/GM)=  2.7327 RHO(GM/CU-CM)=0.943152E-05
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 1.1796 H(KCAL/GM)=  2.6105 RHO(GM/CU-CM)=0.132116E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 1.0711 H(KCAL/GM)=  2.5502 RHO(GM/CU-CM)=0.159160E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 0.9472 H(KCAL/GM)=  2.4931 RHO(GM/CU-CM)=0.199011E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 300.0  S(CAL/GM-DEG)= 0.8000 H(KCAL/GM)=  2.4420 RHO(GM/CU-CM)=0.265269E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 200.00 S(CAL/GM-DEG)= 0.5465 H(KCAL/GM)=  2.4063 RHO(GM/CU-CM)=0.398021E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
P(PSIA)=  0.10000E-00 T(DEG-K)= 100.00 S(CAL/GM-DEG)= 0.3879 H(KCAL/GM)=  2.3806 RHO(GM/CU-CM)=0.795958E-04
           LIOH    COND    PRESENT
           LIF     COND    PRESENT
           LICL   LIQUID   PRESENT
           LI2O    COND    PRESENT
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P(PSIA)= 0.10000E-01 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 6.9228 H(KCAL/GM)= 13.5644 RHO(GM/CU-CM)=0.189309E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 6.9054 H(KCAL/GM)= 13.4958 RHO(GM/CU-CM)=0.194302E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 6.8859 H(KCAL/GM)= 13.4210 RHO(GM/CU-CM)=0.199647E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 6.8631 H(KCAL/GM)= 13.3354 RHO(GM/CU-CM)=0.205434E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 6.8348 H(KCAL/GM)= 13.2322 RHO(GM/CU-CM)=0.211790E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 6.7990 H(KCAL/GM)= 13.1016 RHO(GM/CU-CM)=0.218925E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 6.7491 H(KCAL/GM)= 12.9329 RHO(GM/CU-CM)=0.227087E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 6.6856 H(KCAL/GM)= 12.7204 RHO(GM/CU-CM)=0.236499E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 6.6090 H(KCAL/GM)= 12.4717 RHO(GM/CU-CM)=0.247228E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 6.5244 H(KCAL/GM)= 12.2051 RHO(GM/CU-CM)=0.259184E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 6.4328 H(KCAL/GM)= 11.9258 RHO(GM/CU-CM)=0.272527E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 6.3254 H(KCAL/GM)= 11.6091 RHO(GM/CU-CM)=0.288114E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 6.1832 H(KCAL/GM)= 11.2042 RHO(GM/CU-CM)=0.307749E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 5.9805 H(KCAL/GM)= 10.6471 RHO(GM/CU-CM)=0.334439E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 5.6888 H(KCAL/GM)= 9.8749 RHO(GM/CU-CM)=0.373057E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 5.3064 H(KCAL/GM)= 8.9005 RHO(GM/CU-CM)=0.428984E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 4.8914 H(KCAL/GM)= 7.8837 RHO(GM/CU-CM)=0.502950E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 4.5209 H(KCAL/GM)= 7.0126 RHO(GM/CU-CM)=0.588652E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 4.2389 H(KCAL/GM)= 6.3771 RHO(GM/CU-CM)=0.675458E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 4.0609 H(KCAL/GM)= 5.9937 RHO(GM/CU-CM)=0.750743E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 3.9565 H(KCAL/GM)= 5.7834 RHO(GM/CU-CM)=0.813771E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 3.8841 H(KCAL/GM)= 5.6382 RHO(GM/CU-CM)=0.875187E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 3.8181 H(KCAL/GM)= 5.5161 RHO(GM/CU-CM)=0.940567E-07
P(PSIA)= 0.10000E-01 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 3.7553 H(KCAL/GM)= 5.4070 RHO(GM/CU-CM)=0.101178E-06
P(PSIA)= 0.10000E-01 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 3.6967 H(KCAL/GM)= 5.3094 RHO(GM/CU-CM)=0.108969E-06
P(PSIA)= 0.10000E-01 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 3.6411 H(KCAL/GM)= 5.2231 RHO(GM/CU-CM)=0.117504E-06
P(PSIA)= 0.10000E-01 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 3.1574 H(KCAL/GM)= 4.5183 RHO(GM/CU-CM)=0.153796E-06
LI2O COND PRESENT
P(PSIA)= 0.10000E-01 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 2.9121 H(KCAL/GM)= 4.1863 RHO(GM/CU-CM)=0.182775E-06
LI2O COND PRESENT
P(PSIA)= 0.10000E-01 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 2.5829 H(KCAL/GM)= 3.7791 RHO(GM/CU-CM)=0.235570E-06
LIF COND PRESENT
LI2O COND PRESENT
P(PSIA)= 0.10000E-01 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 2.3235 H(KCAL/GM)= 3.4794 RHO(GM/CU-CM)=0.289788E-06
LIF COND PRESENT
LI2O COND PRESENT
P(PSIA)= 0.10000E-01 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 2.2148 H(KCAL/GM)= 3.3653 RHO(GM/CU-CM)=0.331762E-06
LIF COND PRESENT
LI2O COND PRESENT
P(PSIA)= 0.10000E-01 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 1.9204 H(KCAL/GM)= 3.0881 RHO(GM/CU-CM)=0.460700E-06
LIF COND PRESENT

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           LICL   LIQUID   PRESENT
           LI2?     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= [illegible] S(CAL/GM-DEG)= 1.7?81 H(KCAL/GM)=  2.9?30 RHO(GM/CU-CM)=0.5477?1E-06
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= 70?.? S(CAL/GM-DEG)= 1.71?? H(KCAL/GM)=  2.?243 RHO(GM/CU-CM)=0.627651E-06
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= [illegible] S(CAL/GM-DEG)= 1.24?? H(KCAL/GM)=  2.6212 RHO(GM/CU-CM)=0.126977E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= [illegible] S(CAL/GM-DEG)= 1.11?? H(KCAL/GM)=  2.5520 RHO(GM/CU-CM)=0.159172E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= 4?0.?? S(CAL/GM-DEG)= 0.??50 H(KCAL/GM)=  2.4?44 RHO(GM/CU-CM)=0.199003E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.1[illegible]-01 T([illegible]-K)= 3?0.0 S(CAL/GM-DEG)= 0.8477 H(KCAL/GM)=  2.4420 RHO(GM/CU-CM)=0.265269E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.10000 -01 T(DEG-K)= 2?0.? S(CAL/GM-DEG)= 0.5?42 H(KCAL/GM)=  2.4063 RHO(GM/CU-CM)=0.398021E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.10000E-01 T(DEG-K)= 1?0.00 S(CAL/GM-DEG)= 0.4356 H(KCAL/GM)=  2.3784 RHO(GM/CU-CM)=0.796043E-05
           LIOH     COND   PRESENT
           LIF      COND   PRESENT
           LICL   LIQUID   PRESENT
           LI2O     COND   PRESENT
P(PSIA)=  0.10000E-02 T(DEG-K)=40?0.0? S(CAL/GM-DEG)= 7.4287 H(KCAL/GM)= 13.5?22 RHO(GM/CU-CM)=0.189084E-08
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P(PSIA)=  0.1C000E-02 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 7.4138 H(KCAL/GM)= 13.5232 RHO(GM/CU-CM)=0.193947E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 7.3983 H(KCAL/GM)= 13.4639 RHO(GM/CU-CM)=0.199075E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 7.3823 H(KCAL/GM)= 13.4035 RHO(GM/CU-CM)=0.204498E-08
P(PSIA)=  0.10000E-02 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 7.3652 H(KCAL/GM)= 13.3411 RHO(GM/CU-CM)=0.210255E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 7.3464 H(KCAL/GM)= 13.2746 RHO(GM/CU-CM)=0.216402E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 7.3249 H(KCAL/GM)= 13.2004 RHO(GM/CU-CM)=0.223030E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 7.2983 H(KCAL/GM)= 13.1114 RHO(GM/CU-CM)=0.230289E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 7.2625 H(KCAL/GM)= 12.9952 RHO(GM/CU-CM)=0.238439E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 7.2114 H(KCAL/GM)= 12.8343 RHO(GM/CU-CM)=0.247870E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 7.1390 H(KCAL/GM)= 12.6137 RHO(GM/CU-CM)=0.259018E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 7.0470 H(KCAL/GM)= 12.3422 RHO(GM/CU-CM)=0.272003E-08
P(PSIA)=  0.10000E-02 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 6.9463 H(KCAL/GM)= 12.0553 RHO(GM/CU-CM)=0.286479E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 6.8412 H(KCAL/GM)= 11.7662 RHO(GM/CU-CM)=0.302522E-08
P(PSIA)=  0.10000E-02 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 6.7126 H(KCAL/GM)= 11.4258 RHO(GM/CU-CM)=0.321753E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 6.5228 H(KCAL/GM)= 10.9424 RHO(GM/CU-CM)=0.347647E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 6.2221 H(KCAL/GM)= 10.2070 RHO(GM/CU-CM)=0.386346E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 5.7712 H(KCAL/GM)=  9.1486 RHO(GM/CU-CM)=0.447558E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 5.2382 H(KCAL/GM)=  7.9496 RHO(GM/CU-CM)=0.535759E-08
P(PSIA)=  0.10000E-02 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 4.7671 H(KCAL/GM)=  6.9356 RHO(GM/CU-CM)=0.640688E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 4.4268 H(KCAL/GM)=  6.2369 RHO(GM/CU-CM)=0.746177E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 4.2336 H(KCAL/GM)=  5.8591 RHO(GM/CU-CM)=0.833698E-08
P(PSIA)=  0.10000E-02 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 4.1297 H(KCAL/GM)=  5.6665 RHO(GM/CU-CM)=0.906823E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 4.0478 H(KCAL/GM)=  5.5230 RHO(GM/CU-CM)=0.982052E-08
P(PSIA)=  0.1C000E-02 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 3.9714 H(KCAL/GM)=  5.3969 RHO(GM/CU-CM)=0.106454E-07
P(PSIA)=  0.1C000E-02 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 3.8987 H(KCAL/GM)=  5.2642 RHO(GM/CU-CM)=0.115554E-07
P(PSIA)=  0.1C000E-02 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 3.8316 H(KCAL/GM)=  5.1869 RHO(GM/CU-CM)=0.125554E-07
P(PSIA)=  0.10000E-02 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 3.3187 H(KCAL/GM)=  4.4971 RHO(GM/CU-CM)=0.163966E-07
          LI2O     COND  PRESENT
P(PSIA)=  0.1C000E-02 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 3.0148 H(KCAL/GM)=  4.1157 RHO(GM/CU-CM)=0.199132E-07
          LI2O     COND  PRESENT
P(PSIA)=  0.1C000E-02 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 2.6464 H(KCAL/GM)=  3.6981 RHO(GM/CU-CM)=0.256535E-07
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.1C000E-02 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 2.3741 H(KCAL/GM)=  3.4081 RHO(GM/CU-CM)=0.321125E-07
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.1C000E-02 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 2.2600 H(KCAL/GM)=  3.2999 RHO(GM/CU-CM)=0.371327E-07
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.1C000E-02 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 1.9106 H(KCAL/GM)=  3.0032 RHO(GM/CU-CM)=0.534877E-07
          LIF      COND  PRESENT
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LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 1.8767 H(KCAL/GM)= 2.9247 RHO(GM/CU-CM)=0.6273E-07
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= 4700.00 S(CAL/GM-DEG)= 1.6956 H(KCAL/GM)= 4.3866 RHO(GM/CU-CM)=0.204899E-06
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= 3900.00 S(CAL/GM-DEG)= 1.4605 H(KCAL/GM)= 3.3722 RHO(GM/CU-CM)=0.245879E-06
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= 3600.00 S(CAL/GM-DEG)= 1.3276 H(KCAL/GM)= 3.2413 RHO(GM/CU-CM)=0.307349E-06
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= 3300.00 S(CAL/GM-DEG)= 1.3044 H(KCAL/GM)= 4.2219 RHO(GM/CU-CM)=0.146946E-06
LI LIQUID PRESENT
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.9535 H(KCAL/GM)= 3.2033 RHO(GM/CU-CM)=0.599162E-06
LI LIQUID PRESENT
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)= 1700.00 S(CAL/GM-DEG)= 0.7565 H(KCAL/GM)= 3.1207 RHO(GM/CU-CM)=0.325738E-05
LI LIQUID PRESENT
LIF PRESENT
LIQUID LIQUID PRESENT
LIQUID PRESENT
P(PSIA)= [illegible] T(DEG-K)=4000.00 S(CAL/GM-DEG)= 7.9309 H(KCAL/GM)= 13.5841 RHO(GM/CU-CM)=0.189062E-03
P(PSIA)= [illegible] T(DEG-K)=3900.00 S(CAL/GM-DEG)= 7.9164 H(KCAL/GM)= 13.5264 RHO(GM/CU-CM)=0.193909E-09
P(PSIA)= [illegible] T(DEG-K)=3800.00 S(CAL/GM-DEG)= 7.9012 H(KCAL/GM)= 13.4684 RHO(GM/CU-CM)=0.199016E-09
P(PSIA)= [illegible] T(DEG-K)=3700.00 S(CAL/GM-DEG)= 7.8862 H(KCAL/GM)= 13.4113 RHO(GM/CU-CM)=0.204395E-09
P(PSIA)= [illegible] T(DEG-K)=3600.00 S(CAL/GM-DEG)= 7.8701 H(KCAL/GM)= 13.3553 RHO(GM/CU-CM)=0.210085E-09
P(PSIA)= [illegible] T(DEG-K)=3500.00 S(CAL/GM-DEG)= 7.8539 H(KCAL/GM)= 13.2956 RHO(GM/CU-CM)=0.216101E-09
P(PSIA)= [illegible] T(DEG-K)=3400.00 S(CAL/GM-DEG)= 7.8370 H(KCAL/GM)= 13.2373 RHO(GM/CU-CM)=0.222485E-09
P(PSIA)= [illegible] T(DEG-K)=3300.00 S(CAL/GM-DEG)= 7.8191 H(KCAL/GM)= 13.1775 RHO(GM/CU-CM)=0.229282E-09

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P(PSIA)=  0.100000E-03 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 7.7996 H(KCAL/GM)= 13.1142 RHO(GM/CU-CM)=0.236561E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 7.7771 H(KCAL/GM)= 13.0435 RHO(GM/CU-CM)=0.244433E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 7.7485 H(KCAL/GM)= 12.9563 RHO(GM/CU-CM)=0.253108E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 7.7073 H(KCAL/GM)= 12.8347 RHO(GM/CU-CM)=0.262986E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 7.6424 H(KCAL/GM)= 12.6500 RHO(GM/CU-CM)=0.274745E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 7.5454 H(KCAL/GM)= 12.3832 RHO(GM/CU-CM)=0.289044E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 7.4276 H(KCAL/GM)= 12.0712 RHO(GM/CU-CM)=0.305603E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 7.3110 H(KCAL/GM)= 11.7737 RHO(GM/CU-CM)=0.323591E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 7.1814 H(KCAL/GM)= 11.4568 RHO(GM/CU-CM)=0.344323E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 6.9827 H(KCAL/GM)= 10.9906 RHO(GM/CU-CM)=0.372458E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 6.6357 H(KCAL/GM)= 10.2113 RHO(GM/CU-CM)=0.416700E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 6.0661 H(KCAL/GM)=  8.9686 RHO(GM/CU-CM)=0.492670E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 5.4003 H(KCAL/GM)=  7.6235 RHO(GM/CU-CM)=0.605550E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 4.9700 H(KCAL/GM)=  6.5879 RHO(GM/CU-CM)=0.733643E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 4.5350 H(KCAL/GM)=  5.9664 RHO(GM/CU-CM)=0.852708E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 4.3777 H(KCAL/GM)=  5.6701 RHO(GM/CU-CM)=0.943982E-09
P(PSIA)=  0.100000E-03 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 4.2778 H(KCAL/GM)=  5.5250 RHO(GM/CU-CM)=0.103042E-08
P(PSIA)=  0.100000E-03 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 4.1854 H(KCAL/GM)=  5.3919 RHO(GM/CU-CM)=0.112606E-08
P(PSIA)=  0.100000E-03 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 4.0973 H(KCAL/GM)=  5.2540 RHO(GM/CU-CM)=0.123280E-08
P(PSIA)=  0.100000E-03 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 4.0168 H(KCAL/GM)=  5.1453 RHO(GM/CU-CM)=0.135065E-08
P(PSIA)=  0.100000E-03 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 3.9702 H(KCAL/GM)=  4.9029 RHO(GM/CU-CM)=0.150164E-08
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E-03 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 3.0524 H(KCAL/GM)=  4.0126 RHO(GM/CU-CM)=0.221208E-08
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E-03 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 2.6067 H(KCAL/GM)=  3.5198 RHO(GM/CU-CM)=0.301035E-08
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E-03 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 2.4190 H(KCAL/GM)=  3.3389 RHO(GM/CU-CM)=0.359581E-08
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.100000E-03 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 2.2764 H(KCAL/GM)=  3.2187 RHO(GM/CU-CM)=0.427488E-08
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.479466-11 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 0.0512 H(KCAL/GM)=  0.0635 RHO(GM/CU-CM)=0.130814E-10
          LIF      COND  PRESENT
P(PSIA)=  0.           T(DEG-K)= 600.00 S(CAL/GM-DEG)= 0.9299 H(KCAL/GM)=  1.2097 RHO(GM/CU-CM)=0.414854E-10
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.           T(DEG-K)= 500.00 S(CAL/GM-DEG)= 0.1607 H(KCAL/GM)=  0.6070 RHO(GM/CU-CM)=0.497825E-10
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
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P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.3812 H(KCAL/GM)= 3.0606 RHO(GM/CU-CM)=0.622282E-10

[illegible]

P(PSIA) [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.2463 H(KCAL/GM)= 1.9849 RHO(GM/CU-CM)=0.135040E-04

[illegible]

P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.0913 H(KCAL/GM)= 1.8556 RHO(GM/CU-CM)=0.550613E-04

[illegible]

P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.0113 H(KCAL/GM)= 1.8433 RHO(GM/CU-CM)=0.299344E-03

[illegible]

P(PSIA)= 0.100000E-04 T(DEG-K)=4[illegible] S(CAL/GM-DEG)= 8.4326 H(KCAL/GM)= 13.5842 RHO(GM/CU-CM)=0.189059E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.4190 H(KCAL/GM)= 13.5263 RHO(GM/CU-CM)=0.193907E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.4031 H(KCAL/GM)= 13.4689 RHO(GM/CU-CM)=0.199010E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.3879 H(KCAL/GM)= 13.4116 RHO(GM/CU-CM)=0.204336E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 8.3723 H(KCAL/GM)= 13.3548 RHO(GM/CU-CM)=0.210066E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.3562 H(KCAL/GM)= 13.2978 RHO(GM/CU-CM)=0.216071E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.3398 H(KCAL/GM)= 13.2412 RHO(GM/CU-CM)=0.222428E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.3229 H(KCAL/GM)= 13.1846 RHO(GM/CU-CM)=0.229174E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.3054 H(KCAL/GM)= 13.1279 RHO(GM/CU-CM)=0.236348E-10
P(PSIA)= [illegible] T(DEG-K)=[illegible] S(CAL/GM-DEG)= 8.2872 H(KCAL/GM)= 13.0705 RHO(GM/CU-CM)=0.243997E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=3[illegible] S(CAL/GM-DEG)= 8.2679 H(KCAL/GM)= 13.0115 RHO(GM/CU-CM)=0.252187E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 8.2464 H(KCAL/GM)= 12.9481 RHO(GM/CU-CM)=0.261019E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 8.2203 H(KCAL/GM)= 12.8734 RHO(GM/CU-CM)=0.270680E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 8.1933 H(KCAL/GM)= 12.7721 RHO(GM/CU-CM)=0.281571E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 8.1210 H(KCAL/GM)= 12.6072 RHO(GM/CU-CM)=0.294540E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 9.0147 H(KCAL/GM)= 12.3365 RHO(GM/CU-CM)=0.310803E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 7.8744 H(KCAL/GM)= 11.9932 RHO(GM/CU-CM)=0.330264E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 7.7424 H(KCAL/GM)= 11.6827 RHO(GM/CU-CM)=0.351126E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 7.6001 H(KCAL/GM)= 11.3632 RHO(GM/CU-CM)=0.375056E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 7.3536 H(KCAL/GM)= 10.8344 RHO(GM/CU-CM)=0.409585E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 6.8739 H(KCAL/GM)= 9.8536 RHO(GM/CU-CM)=0.469556E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 6.0897 H(KCAL/GM)= 8.3261 RHO(GM/CU-CM)=0.579754E-10
P(PSIA)= 0.100000E-04 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 5.3422 H(KCAL/GM)= 6.9412 RHO(GM/CU-CM)=0.727397E-10

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P(PSIA)=  0.10000E-04 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 4.8558 H(KCAL/GM)=  6.0879 RHO(GM/CU-CM)=0.874007E-10
P(PSIA)=  0.10000E-04 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 4.6226 H(KCAL/GM)=  5.7012 RHO(GM/CU-CM)=0.989145E-10
P(PSIA)=  0.10000E-04 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 4.3836 H(KCAL/GM)=  5.5166 RHO(GM/CU-CM)=0.108839E-09
P(PSIA)=  0.10000E-04 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 4.1339 H(KCAL/GM)=  5.3575 RHO(GM/CU-CM)=0.119954E-09
P(PSIA)=  0.10000E-04 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 4.2880 H(KCAL/GM)=  5.2145 RHO(GM/CU-CM)=0.132547E-09
P(PSIA)=  0.10000E-04 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 4.1937 H(KCAL/GM)=  5.0965 RHO(GM/CU-CM)=0.146480E-09
P(PSIA)=  0.10000E-04 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 3.4481 H(KCAL/GM)=  4.2371 RHO(GM/CU-CM)=0.204288E-09
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E-04 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 3.1266 H(KCAL/GM)=  3.8973 RHO(GM/CU-CM)=0.249063E-09
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E-04 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 2.5761 H(KCAL/GM)=  3.3739 RHO(GM/CU-CM)=0.351861E-09
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E-04 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 2.4561 H(KCAL/GM)=  3.2714 RHO(GM/CU-CM)=0.408566E-09
          LIF     COND  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E-04 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 2.0413 H(KCAL/GM)=  2.9667 RHO(GM/CU-CM)=0.597715E-09
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.25447E-04 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 1.7086 H(KCAL/GM)=  3.3439 RHO(GM/CU-CM)=0.189555E-08
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.25385E-04 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 2.6477 H(KCAL/GM)=  5.3061 RHO(GM/CU-CM)=0.227466E-08
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.10000E-04 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 1.6474 H(KCAL/GM)=  4.2819 RHO(GM/CU-CM)=0.109845E-08
          LI    LIQUID  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.11148E-04 T(DEG-K)= 300.00 S(CAL/GM-DEG)= 1.4732 H(KCAL/GM)=  4.2219 RHO(GM/CU-CM)=0.163279E-09
          LI    LIQUID  PRESENT
          LIF     COND  PRESENT
          LICL  LIQUID  PRESENT
          LI2O    COND  PRESENT
P(PSIA)=  0.30335E-04 T(DEG-K)= 200.00 S(CAL/GM-DEG)= 1.1222 H(KCAL/GM)=  3.2093 RHO(GM/CU-CM)=0.665757E-08
          LI    LIQUID  PRESENT
          LIF     COND  PRESENT
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         LIQL  LIQUID  PRESENT
         LI2O   COND   PRESENT
P(PSIA)= [illegible] T(DEG-K)= [illegible] S(CAL/GM-DEG)= 0.9253 H(KCAL/GM)=  3.1207 RHO(GM/CU-CM)=0.361943E-07
         LIF    COND   PRESENT
         LIQL  LIQUID  PRESENT
         LI2O   COND   PRESENT
P(PSIA)= 0.100000E-05 T(DEG-K)=4000.00 S(CAL/GM-DEG)= 8.9344 H(KCAL/GM)= 13.5342 RHO(GM/CU-CM)=0.189064E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3900.00 S(CAL/GM-DEG)= 8.9197 H(KCAL/GM)= 13.5264 RHO(GM/CU-CM)=0.193912E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3800.00 S(CAL/GM-DEG)= 8.9044 H(KCAL/GM)= 13.4669 RHO(GM/CU-CM)=0.199014E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3700.00 S(CAL/GM-DEG)= 8.8895 H(KCAL/GM)= 13.4116 RHO(GM/CU-CM)=0.204395E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3600.00 S(CAL/GM-DEG)= 8.8740 H(KCAL/GM)= 13.3547 RHO(GM/CU-CM)=0.210071E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3500.00 S(CAL/GM-DEG)= 8.8580 H(KCAL/GM)= 13.2980 RHO(GM/CU-CM)=0.216066E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3400.00 S(CAL/GM-DEG)= 8.8416 H(KCAL/GM)= 13.2416 RHO(GM/CU-CM)=0.222423E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3300.00 S(CAL/GM-DEG)= 8.8243 H(KCAL/GM)= 13.1953 RHO(GM/CU-CM)=0.229163E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3200.00 S(CAL/GM-DEG)= 8.8074 H(KCAL/GM)= 13.1293 RHO(GM/CU-CM)=0.236326E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3100.00 S(CAL/GM-DEG)= 8.7993 H(KCAL/GM)= 13.0733 RHO(GM/CU-CM)=0.243952E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=3000.00 S(CAL/GM-DEG)= 8.7715 H(KCAL/GM)= 13.0174 RHO(GM/CU-CM)=0.252089E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2900.00 S(CAL/GM-DEG)= 8.7524 H(KCAL/GM)= 12.9611 RHO(GM/CU-CM)=0.260796E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2800.00 S(CAL/GM-DEG)= 8.7323 H(KCAL/GM)= 12.9039 RHO(GM/CU-CM)=0.270145E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2700.00 S(CAL/GM-DEG)= 8.7104 H(KCAL/GM)= 12.8435 RHO(GM/CU-CM)=0.280247E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2600.00 S(CAL/GM-DEG)= 8.6842 H(KCAL/GM)= 12.7741 RHO(GM/CU-CM)=0.291301E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2500.00 S(CAL/GM-DEG)= 8.6463 H(KCAL/GM)= 12.6776 RHO(GM/CU-CM)=0.303742E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2400.00 S(CAL/GM-DEG)= 8.5765 H(KCAL/GM)= 12.5072 RHO(GM/CU-CM)=0.318874E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2300.00 S(CAL/GM-DEG)= 8.4452 H(KCAL/GM)= 12.1932 RHO(GM/CU-CM)=0.338459E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2200.00 S(CAL/GM-DEG)= 8.2776 H(KCAL/GM)= 11.8221 RHO(GM/CU-CM)=0.361838E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2100.00 S(CAL/GM-DEG)= 8.1363 H(KCAL/GM)= 11.5178 RHO(GM/CU-CM)=0.386154E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=2000.00 S(CAL/GM-DEG)= 7.9548 H(KCAL/GM)= 11.1463 RHO(GM/CU-CM)=0.416313E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=1900.00 S(CAL/GM-DEG)= 7.5657 H(KCAL/GM)= 10.3996 RHO(GM/CU-CM)=0.466746E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=1800.00 S(CAL/GM-DEG)= 6.7675 H(KCAL/GM)=  8.9179 RHO(GM/CU-CM)=0.563494E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=1700.00 S(CAL/GM-DEG)= 5.7925 H(KCAL/GM)=  7.2100 RHO(GM/CU-CM)=0.735510E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=1600.00 S(CAL/GM-DEG)= 5.1614 H(KCAL/GM)=  6.1657 RHO(GM/CU-CM)=0.906926E-11
P(PSIA)= 0.100000E-05 T(DEG-K)=1500.00 S(CAL/GM-DEG)= 4.8572 H(KCAL/GM)=  5.6915 RHO(GM/CU-CM)=0.104540E-10
P(PSIA)= 0.100000E-05 T(DEG-K)=1400.00 S(CAL/GM-DEG)= 4.7203 H(KCAL/GM)=  5.4936 RHO(GM/CU-CM)=0.115898E-10
P(PSIA)= 0.100000E-05 T(DEG-K)=1300.00 S(CAL/GM-DEG)= 4.5918 H(KCAL/GM)=  5.3194 RHO(GM/CU-CM)=0.128920E-10
P(PSIA)= 0.100000E-05 T(DEG-K)=1200.00 S(CAL/GM-DEG)= 4.4666 H(KCAL/GM)=  5.1628 RHO(GM/CU-CM)=0.143860E-10
P(PSIA)= 0.100000E-05 T(DEG-K)=1100.00 S(CAL/GM-DEG)= 4.2103 H(KCAL/GM)=  4.8756 RHO(GM/CU-CM)=0.167805E-10
         LI2O   COND   PRESENT
P(PSIA)= 0.100000E-05 T(DEG-K)=1000.00 S(CAL/GM-DEG)= 3.4159 H(KCAL/GM)=  4.0309 RHO(GM/CU-CM)=0.237144E-10
         LI2O   COND   PRESENT
P(PSIA)= 0.100000E-05 T(DEG-K)= 900.00 S(CAL/GM-DEG)= 3.0403 H(KCAL/GM)=  3.6785 RHO(GM/CU-CM)=0.298666E-10
         LIF    COND   PRESENT
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          LI2O     COND  PRESENT
P(PSIA)=  0.10000E-05 T(DEG-K)= 800.00 S(CAL/GM-DEG)= 2.5950 H(KCAL/GM)=  3.2888 RHO(GM/CU-CM)=0.402967E-10
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10000E-05 T(DEG-K)= 700.00 S(CAL/GM-DEG)= 2.4434 H(KCAL/GM)=  3.1770 RHO(GM/CU-CM)=0.483742E-10
          LIF      COND  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10001E-05 T(DEG-K)= 600.00 S(CAL/GM-DEG)= 1.9838 H(KCAL/GM)=  2.8711 RHO(GM/CU-CM)=0.730735E-10
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.27125E-05 T(DEG-K)= 500.00 S(CAL/GM-DEG)= 1.6973 H(KCAL/GM)=  3.2853 RHO(GM/CU-CM)=0.238361E-09
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.27125E-05 T(DEG-K)= 400.00 S(CAL/GM-DEG)= 2.4788 H(KCAL/GM)=  5.1957 RHO(GM/CU-CM)=0.297952E-09
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.27125E-05 T(DEG-K)= 300.00 S(CAL/GM-DEG)= 8.1050 H(KCAL/GM)= 28.4562 RHO(GM/CU-CM)=0.397269E-09
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10033E-05 T(DEG-K)= 200.00 S(CAL/GM-DEG)= 1.2804 H(KCAL/GM)=  4.1759 RHO(GM/CU-CM)=0.220417E-09
          LI       LIQUID  PRESENT
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
P(PSIA)=  0.10033E-05 T(DEG-K)= 100.00 S(CAL/GM-DEG)= 1.0907 H(KCAL/GM)=  3.1775 RHO(GM/CU-CM)=0.440834E-09
          LIF      COND  PRESENT
          LICL   LIQUID  PRESENT
          LI2O     COND  PRESENT
```

APPENDIX G

Equilibrium Composition Sample Output

```
    4N2 + O2 + CH2  FROM  4333 DEGREES TO 1000  DEGREES
    S A GREENE
          1           7           4           2
  14.696                 6000.       1000.         500.          2.
 N2                            0.          1
N   2.
 O2                            0.          1
O   2.
 CH2                        28.0693        2
C   1.      H   2.
 ION                           0.          1
E   1.
```

********** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
C	HEAT OF FORMATION	170.8860
N	HEAT OF FORMATION	112.9650
O	HEAT OF FORMATION	59.5590
E	HEAT OF FORMATION	0.0002
CHNO	HEAT OF FORMATION	-27.9000
CHN	HEAT OF FORMATION	31.2000
CHO	HEAT OF FORMATION	-2.9000
CH	HEAT OF FORMATION	142.0060
HNO	HEAT OF FORMATION	14.0890
HN	HEAT OF FORMATION	79.2000
OH-	HEAT OF FORMATION	-31.7425
HO	HEAT OF FORMATION	9.3300
CH2O	HEAT OF FORMATION	-27.7000
CH2	HEAT OF FORMATION	66.8350
C2H2	HEAT OF FORMATION	54.1900
H2N	HEAT OF FORMATION	40.3000
H2O	HEAT OF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
CH3	HEAT OF FORMATION	32.0000
H3N	HEAT OF FORMATION	-11.0400
H3O+	HEAT OF FORMATION	139.0000
CH4	HEAT OF FORMATION	-17.9251
C2H4O	HEAT OF FORMATION	-12.1900
C2H4	HEAT OF FORMATION	12.4960
CH6	HEAT OF FORMATION	-17.8950
CN-	HEAT OF FORMATION	21.0504
CN	HEAT OF FORMATION	94.0000
CO+	HEAT OF FORMATION	305.6472
CO	HEAT OF FORMATION	-26.4170
CO2+	HEAT OF FORMATION	223.7088
CO2	HEAT OF FORMATION	-94.0540
C-	HEAT OF FORMATION	143.5641
C+	HEAT OF FORMATION	431.2600
C2N2	HEAT OF FORMATION	73.8700
C2+	HEAT OF FORMATION	473.3040
C2	HEAT OF FORMATION	197.0280
C3O2	HEAT OF FORMATION	-8.3000
C3	HEAT OF FORMATION	189.6700

				C4N2	HEAT OF FORMATION	127.5000
				C4	HEAT OF FORMATION	242.3210
				C5	HEAT OF FORMATION	242.3740
				NO+	HEAT OF FORMATION	234.8979
				NO	HEAT OF FORMATION	21.6520
				NO2	HEAT OF FORMATION	8.0600
				N+	HEAT OF FORMATION	449.5650
				N2O	HEAT OF FORMATION	19.5000
				N2O3	HEAT OF FORMATION	20.1850
				N2O4	HEAT OF FORMATION	10.5540
				N2O5	HEAT OF FORMATION	3.0600
				N2+	HEAT OF FORMATION	359.8000
				N2	HEAT OF FORMATION	0.
				O-	HEAT OF FORMATION	25.0501
				O+	HEAT OF FORMATION	373.1501
				O2-	HEAT OF FORMATION	-3.5300
				O2+	HEAT OF FORMATION	371.3000
				O2	HEAT OF FORMATION	0.
				O3	HEAT OF FORMATION	34.0000
				C SOLID	HEAT OF FORMATION	0.
	4	+01 1	+01 1	+01 0	+00	

AEROSPACE CORPORATION

55 5/14/63 S A GREENE

4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES

COMPONENT	WEIGHT PERCENT	MOLES	MOLE PERCENT
N2	70.885752	4.000000	66.666667
O2	20.241506	1.000000	16.666667
CH2	8.872737	1.000000	16.666667
ION	-0.	-0.	-0.

ELEMENTS	MOLES	MASS BALANCE (MOLES/GM)
H	0.3333	0.12650941E-01
C	0.1667	0.63254708E-02
N	1.3333	0.50603767E-01
O	0.3333	0.12650941E-01
E	-0.	-0.

EQUILIBRIUM GAS [illegible] SELECTED, UNHEATED SYSTEM ENTHALPY (KCAL/GM)= 1.57454

TAPE 55 5/14/63
4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES

S A GREENE

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 6000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 5.1985
SYSTEM ENTROPY (CAL/GM-DEG) 3.4199
SYSTEM GAS CP 0.39945

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.229143E-00	0.12610488E-01	0.22914350E-00	4.9680	0.280334E 18	42.3065	-138.6888
C	0.792088E-02	0.43591241E-03	0.79209066E-02	5.5410	0.969042E 16	53.0101	-25.2321
N	0.146218E-00	0.80468547E-02	0.14621833E-00	6.1000	0.178883E 18	51.8221	-166.3023
O	0.121870E-00	0.67068898E-02	0.12187000E-00	5.3230	0.149096E 18	53.6544	-231.3280
E	0.319603E-03	0.17588834E-04	0.31960439E-03	4.9680	0.391003E 15	19.9016	-29.6015
CHNO	0.554533E-09	0.30517775E-10	0.55453444E-09	19.6790	0.678416E 09	106.3947	-430.7053
CHN	0.318105E-05	0.17506371E-06	0.31810595E-05	16.1260	0.389170E 13	86.6848	-277.4738
CHO	0.102719E-05	0.56529631E-07	0.10271924E-05	13.7840	0.125667E 13	88.4396	-331.1931
CH	0.347633E-05	0.19131396E-06	0.34763406E-05	9.6090	0.425295E 13	68.0724	-89.3051
HNO	0.504486E-08	0.27763534E-09	0.50448749E-08	14.7582	0.617189E 10	84.0846	-374.1114
HN	0.128052E-03	0.70471123E-05	0.12805214E-03	9.5490	0.156559E 15	67.3384	-238.6128
OH-	0.958657E-09	0.52769075E-10	0.95885985E-09	9.3715	0.117307E 10	67.6558	-290.6537
HO	0.201451E-03	0.11086509E-04	0.20145149E-03	9.3700	0.246455E 15	67.6813	-311.2130
CH2O	0.118728E-10	0.65339807E-12	0.11872809E-10	19.6480	0.145252E 08	98.3342	-351.9027
CH2	0.406577E-08	0.22375312E-09	0.40657882E-08	14.6800	0.497408E 10	78.2717	-165.0650
C2H2	0.118190E-10	0.65044133E-12	0.11819083E-10	22.5210	0.144594E 08	100.0011	-178.3449
H2N	0.123450E-07	0.67938606E-09	0.12345034E-07	13.6720	0.151029E 11	77.7977	-284.6139
H2O	0.162752E-06	0.89568013E-08	0.16275284E-06	14.4220	0.199112E 12	78.0652	-382.5619
H2	0.198771E-03	0.10939033E-04	0.19877173E-03	10.1000	0.243177E 15	55.0205	-210.8857
CH3	0.384337E-12	0.21151339E-13	0.38433818E-12	19.5430	0.470199E 06	89.7524	-210.8317
H3N	0.318422E-11	0.17523838E-12	0.31842334E-11	19.4610	0.389559E 07	89.1970	-342.3494
H3O+	0.250490E-12	0.13785304E-13	0.25049093E-12	19.4606	0.306450E 06	89.2049	-253.6639
CH4	0.	0.	0.	25.4085	0.	99.8967	-258.1132
C2H4O	0.	0.	0.	37.2770	0.	142.6814	-351.1331
C2H4	0.	0.	0.	31.3470	0.	123.1757	-242.8006
CH6	0.	0.	0.	25.4090	0.	99.8649	-188.5714
CN-	0.207915E-06	0.11442234E-07	0.20791531E-06	11.0297	0.254363E 12	74.4218	-214.2584
CN	0.231464E-02	0.12738240E-03	0.23146487E-02	9.1390	0.283174E 16	72.9116	-199.7903
CO+	0.547027E-06	0.30104732E-07	0.54702909E-06	9.1748	0.669234E 12	71.6341	-41.8565

CO		0.104668E-00	0.57602105E-02	0.10466802E-00	9.1750	0.128051E 18	71.6331	-312.4347
CO2+		0.167359E-09	0.92103356E-11	0.16735978E-09	15.5297	0.204748E 09	90.4923	-201.7948
CO2		0.940276E-05	0.51746542E-06	0.94027955E-05	15.5250	0.115034E 14	90.3667	-457.7616
C-		0.120483E-07	0.66305628E-09	0.120483CAE-07	5.5406	C.147399E 11	53.0096	8.9293
C+		0.107318E-04	0.59060833E-06	0.10731865E-04	4.9823	0.131293E 14	51.8771	179.0782
C2N2		0.149221E-08	0.82121190E-10	0.14922132E-08	20.7590	0.182557E 10	112.8529	-301.9747
C2+		0.167564E-08	0.92215879E-10	0.16756425E-08	9.2508	0.204998E 10	74.3292	200.6641
C2		0.359433E-05	0.19780815E-06	0.35943458E-05	9.8550	0.439732E 13	75.3156	-16.3671
C3O2		0.516395E-14	0.28418934E-15	0.51639667E-14	26.6920	0.631759E 04	131.1176	-369.3538
C3		0.489485E-09	0.26937724E-10	0.48948181E-09	14.8350	0.598831E 09	89.8193	6.8493
C4N2		0.	0.	0.	32.6240	0.	155.5473	-255.6465
C4		0.170123E-13	0.93624160E-15	0.17012321E-13	20.7700	0.208128E 05	112.9960	46.3489
C5		0.	0.	0.	26.7030	0.	130.0507	68.4995
NO+		0.305410E-03	0.16807712E-04	0.30541071E-03	9.3128	0.373639E 15	75.1873	-223.5777
NO		0.273403E-02	0.15046259E-03	0.27340358E-02	9.1940	0.334481E 16	75.1405	-375.2795
NO2		0.617326E-08	0.33973507E-09	0.61732809E-08	13.8640	0.755238E 10	94.4630	-476.6860
N+		0.522118E-06	0.28733869E-07	0.52211932E-06	6.1000	0.638760E 12	51.8219	108.8177
N2O		0.118737E-06	0.65344762E-08	0.11873709E-06	14.8360	0.145263E 12	91.8203	-444.7424
N2O3		0.	0.	0.	25.7490	0.	143.3287	-688.3897
N2O4		0.	0.	0.	31.6840	0.	156.6495	-744.0563
N2O5		0.	0.	0.	37.6250	0.	174.8453	-826.4638
N2+		0.194752E-06	0.10717826E-07	0.19475220E-06	9.1652	0.238259E 12	69.9966	-68.6508
N2		0.383904E-00	0.21127528E-01	0.38390551E-00	9.1650	0.469669E 18	70.0080	-367.0391
O-		0.338631E-06	0.18646999E-07	0.33883215E-06	5.3234	0.414527E 12	53.6547	-204.3581
O+		0.299808E-05	0.16499413E-06	0.29980864E-05	5.3234	0.366785E 13	53.6547	20.7799
O2-		0.803125E-11	0.44198658E-12	0.80312794E-11	10.2790	0.982545E 07	74.8898	-333.7984
O2+		0.755170E-11	0.41559540E-12	0.75517289E-11	10.2790	0.923877E 07	74.8898	-81.9304
O2		0.386848E-04	0.21289527E-05	0.38684917E-04	10.2760	0.473271E 14	74.8826	-391.7057
O3		0.361046E-11	0.19869570E-12	0.36104731E-11	13.8840	0.441705E 07	95.3925	-455.1232
C	SOLID	0.	0.	0.	6.6060	0.	16.4818	26.6650

PRESSURE (ATM) 0.10000GE 01
TEMPERATURE (DEG K) 5500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 4.3267
SYSTEM ENTROPY (CAL/GM-DEG) 3.2689
SYSTEM GAS CP 0.38904

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.240680E-00	0.12565862E-01	0.24068087E-00	4.9680	0.321217E 18	41.8742	-117.6417
C	0.122559E-02	0.63987990E-04	0.12255972E-02	5.5090	0.163570E 16	52.5290	1.1555
N	0.644844E-01	0.33666998E-02	0.64484255E-01	5.8500	0.860517E 17	51.3019	-140.5171
O	0.118327E-00	0.61778493E-02	0.11832774E-00	5.2690	0.157922E 18	53.1936	-204.6149
E	0.150274E-03	0.78457807E-05	0.15027455E-03	4.9680	0.200559E 15	19.4693	-19.7572
CHNO	0.106382E-08	0.55541783E-10	0.10638223E-08	19.6440	0.141979E 10	104.6834	-377.9263
CHN	0.242097E-05	0.12639838E-06	0.24209778E-05	16.0010	0.323108E 13	85.2664	-234.4724
CHO	0.157979E-05	0.82480592E-07	0.15797962E-05	13.7600	0.210842E 13	87.2414	-287.2597
CH	0.111056E-05	0.57982398E-07	0.11105687E-05	9.5330	0.148218E 13	67.2398	-55.4753
HNO	0.121074E-07	0.63212556E-09	0.12107448E-07	14.7310	0.161588E 11	82.8016	-332.3853
HN	0.121587E-03	0.63480589E-05	0.12158787E-03	9.3900	0.162273E 15	66.6840	-205.1570
OH-	0.179656E-08	0.93798365E-10	0.17965717E-08	9.3002	0.239773E 10	66.8434	-257.0257
HO	0.477715E-03	0.24941442E-04	0.47771717E-03	9.3060	0.637569E 15	66.8696	-277.5762
CH2O	0.344239E-10	0.17975798E-11	0.34430036E-10	19.6070	0.459509E 08	96.6267	-303.1587
CH2	0.366934E-08	0.19157598E-09	0.36693601E-08	14.6390	0.489719E 10	76.9965	-126.2460
C2H2	0.632856E-11	0.33041284E-12	0.63285789E-11	22.3090	0.844522E 07	98.0509	-129.8245
H2N	0.260064E-07	0.13577894E-08	0.26006488E-07	13.6280	0.347087E 11	76.6100	-246.0079
H2O	0.104469E-05	0.54543066E-07	0.10446933E-05	14.3030	0.139426E 13	76.8152	-343.8364
H2	0.511515E-03	0.26706138E-04	0.51151735E-03	9.9300	0.682679E 15	54.1489	-183.5898
CH3	0.734576E-12	0.38352105E-13	0.73457898E-12	19.4970	0.980381E 06	88.0526	-166.3736
H3N	0.156519E-10	0.81718557E-12	0.15652005E-10	19.3850	0.208894E 08	87.5065	-296.1663
H3O+	0.989619E-12	0.51667851E-13	0.98962280E-12	19.3852	0.132077E 07	87.5148	-209.4781
CH4	0.	0.	0.	25.3296	0.	97.6892	-208.7090
C2H4O	0.	0.	0.	37.1870	0.	139.4412	-280.5884
C2H4	0.	0.	0.	31.2640	0.	120.4525	-181.8884
CH6	0.	0.	0.	25.3300	0.	97.6776	-139.1748
CN-	0.625881E-07	0.32677164E-08	0.62588370E-07	11.0400	0.835315E 11	73.4616	-177.2844
CN	0.721182E-03	0.37652604E-04	0.72118488E-03	9.1120	0.962505E 15	72.1171	-163.5280
CO+	0.857043E-07	0.44746085E-08	0.85704637E-07	9.1379	0.114383E 12	70.8375	-6.2351

CO		0.119175E-00	0.[illegible]E-02	0.11917563E-00	[illegible].1360	0.159054E 18	70.8366	-276.8148
CO2+		0.727168E-10	[illegible]	[illegible]	15.4549	0.970491E 08	89.1397	-155.8815
CO2		0.267087E-04	[illegible]	[illegible]	15.4150	0.356460E 14	89.0206	-412.9097
C-		0.132694E-04	[illegible]	0.13269421E-04	[illegible].5034	0.177046E 10	52.5286	35.3155
C+		0.399475E-06	0.20[illegible]336E-07	0.39947690E-06	4.9748	0.531814E 12	51.4440	204.9150
C2N2		0.312663E-09	0.15[illegible]96E-10	0.[illegible]E-09	26.7340	0.417287E 09	111.0475	-245.9928
C2+		0.271971E-10	0.14[illegible]E-11	0.27197239E-10	[illegible].2162	0.362479E 08	73.5257	237.6306
C2		0.259737E-06	[illegible]	[illegible]	[illegible].8520	0.359357E 12	74.4578	21.0806
C3O2		0.241372E-14	[illegible]	0.24137297E-14	26.6660	0.322140E 04	128.7962	-304.3773
C3		0.225647E-10	[illegible]	0.22564706E-10	14.8220	0.301220E 08	88.5049	51.5737
C4N2		0.	0.	0.	32.5920	0.	152.7100	-178.5720
C4		0.	0.	0.	20.7520	0.	111.1697	102.4008
C5		0.	0.	0.	26.6790	0.	127.7285	132.9520
NO+		0.149608E-03	0.781102757E-05	0.14960890E-03	[illegible].2648	0.199670E 15	74.3792	-186.1838
NO		0.393777E-02	0.20559845E-03	0.39377488E-02	[illegible].1640	0.525538E 16	74.3411	-337.9017
NO2		0.154042E-07	[illegible]	0.[illegible]E-07	13.8550	0.205615E 11	93.2572	-429.7525
N+		0.306163E-07	0.15994749E-08	0.30616469E-07	5.8497	0.408612E 11	51.3021	134.5997
N2O		0.179891E-06	0.93920901E-08	0.17989187E-06	14.8230	0.240087E 12	90.5300	-399.1506
N2O3		0.	0.	0.	25.7330	0.	141.0691	-617.2782
N2O4		0.	0.	0.	31.6630	0.	153.8939	-666.4132
N2O5		0.	0.	0.	37.6000	0.	171.5729	-739.8492
N2+		0.254244E-07	0.13274036E-08	0.25424492E-07	[illegible].1180	0.339319E 11	69.2012	-33.8488
N2		0.449910E-00	0.23489763E-01	0.44991235E-00	9.1160	0.600460E 18	69.2122	-332.2293
O-		0.247323E-06	0.12912699E-07	0.24732403E-06	5.2691	0.330083E 12	53.1939	-177.6445
O+		0.461119E-06	0.24074980E-07	0.46112134E-06	5.2691	0.615420E 12	53.1939	47.4935
O2-		0.115255E-10	0.60174357E-12	0.11525525E-10	16.2280	0.153822E 08	73.9976	-296.5736
O2+		0.186252E-11	0.97241972E-13	0.18625290E-11	10.2280	0.248576E 07	73.9976	-44.7056
O2		0.935036E-04	0.48818104E-05	0.93504000E-04	10.2250	0.124792E 15	73.9905	-354.4830
O3		0.106943E-10	0.55834884E-12	0.10694362E-10	13.8789	0.142729E 08	94.1646	-407.7245
C	SOLID	0.	0.	0.	6.4940	0.	15.9120	34.7651

4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 5000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 3.8383
SYSTEM ENTROPY (CAL/GM-DEG) 3.1761
SYSTEM GAS CP 0.38397

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.24427CE-00	0.12429687E-01	0.24426995E-00	4.9680	0.358607E 18	41.4004	-96.8196
C	0.114639E-03	0.58334297E-05	0.11463936E-03	5.4680	0.168300E 15	52.0064	27.2881
N	0.228862E-01	0.11645637E-02	0.22886168E-01	5.6080	0.335987E 17	50.7568	-115.0049
O	0.116687E-00	0.59376292E-02	0.11668711E-00	5.2100	0.171306E 18	52.6941	-178.1408
E	0.615044E-04	0.31296520E-05	0.61504357E-04	4.9680	0.902932E 14	18.9958	-10.1391
CHNO	0.187408E-08	0.95362591E-10	0.18740789E-08	19.5970	0.275129E 10	102.8138	-326.0476
CHN	0.138651E-05	0.70552640E-07	0.13865103E-05	15.8620	0.203550E 13	83.7682	-192.2043
CHO	0.225124E-05	0.11455452E-06	0.22512414E-05	13.7290	0.330500E 13	85.9313	-243.9705
CH	0.236091E-06	0.12013520E-07	0.23609138E-06	9.4530	0.346601E 12	66.3348	-22.0776
HNO	0.318634E-07	0.16213704E-08	0.31863397E-07	14.6956	0.467779E 11	81.3993	-291.3297
HN	0.102720E-03	0.52269255E-05	0.10272026E-03	9.4070	0.150801E 15	65.6117	-172.1113
OH-	0.367676E-08	0.18709206E-09	0.36767592E-08	9.2256	0.539777E 10	65.9606	-223.8218
HO	0.131007E-02	0.66663156E-04	0.13100736E-02	9.2250	0.192329E 16	65.9862	-244.3575
CH2O	0.100912E-09	0.51349289E-11	0.10091233E-09	19.5520	0.148147E 09	94.7609	-255.3060
CH2	0.259656E-08	0.13212627E-09	0.25965639E-08	14.5850	0.381196E 10	75.6035	-88.0894
C2H2	0.212262E-11	0.10800968E-12	0.21226212E-11	22.0770	0.311617E 07	95.9356	-80.3204
H2N	0.545994E-07	0.27782928E-08	0.54599398E-07	13.5710	0.801562E 11	75.3130	-208.0191
H2O	0.906331E-05	0.46118696E-06	0.90633102E-05	14.1740	0.133056E 14	75.4581	-305.7631
H2	0.145660E-02	0.74119045E-04	0.14565977E-02	9.7480	0.213840E 16	53.2116	-156.7491
CH3	0.122410E-11	0.62288287E-13	0.12240981E-11	19.4200	0.179707E 07	86.1982	-122.8049
H3N	0.872703E-10	0.44407533E-11	0.87270302E-10	19.2870	0.128120E 09	85.6634	-254.8665
H3O+	0.463941E-11	0.23607654E-12	0.46394090E-11	19.2874	0.681101E 07	85.6717	-166.1746
CH4	0.775557E-15	0.39464236E-16	0.77555667E-15	25.2269	0.113858E 04	95.2798	-160.4576
C2H4O	0.	0.	0.	37.0710	0.	135.9027	-211.7413
C2H4	0.	0.	0.	31.1550	0.	117.4772	-122.3918
CH6	0.	0.	0.	25.2270	0.	95.2684	-90.9306
CN-	0.121715E-07	0.61934847E-09	0.12171522E-07	11.0163	0.178687E 11	72.4100	-140.8120
CN	0.146498E-03	0.74545588E-05	0.14649802E-03	9.0830	0.215070E 15	71.2504	-127.6848
CO+	0.833583E-08	0.42416894E-09	0.83358271E-08	9.0998	0.122376E 11	69.9684	28.9689

CO		0.1239598E-00	0.63076369E-02	0.12395856E-00	9.1000	0.181981E 18	69.9678	-241.6122
CO2+		0.2470228E-10	0.12569714E-11	0.24702177E-10	15.3759	0.362647E 08	87.6660	-112.6744
CO2		0.8542428E-04	0.43468126E-05	0.85424166E-04	15.3060	0.125409E 15	87.5571	-368.7620
C-		0.8163568E-10	0.41560331E-11	0.81635637E-10	5.4682	0.119847E 09	52.0056	61.4511
C+		0.6774978E-08	0.34474465E-09	0.67749698E-08	4.9709	0.994618E 10	50.9700	230.5155
C2N2		0.3283337E-10	0.16707467E-11	0.32833747E-10	20.7130	0.482025E 08	109.0724	-190.9572
C2+		0.1494746E-12	0.76059718E-14	0.14947361E-12	9.1841	0.219439E 06	72.6487	274.1775
C2		0.9240298E-08	0.47019253E-09	0.92402890E-08	9.8550	0.135655E 11	73.5191	58.0762
C3O2		0.6824195E-15	0.34724919E-16	0.66241894E-15	26.6330	0.100184E 04	126.2560	-240.6023
C3		0.3772208E-12	0.19194877E-13	0.37722039E-12	14.8040	0.553789E 06	87.0640	95.6238
C4N2		0.	0.	0.	32.5520	0.	149.6055	-102.9810
C4		0.	0.	0.	20.7280	0.	109.2137	157.5064
C5		0.	0.	0.	26.6480	0.	125.1873	196.1900
NO+		0.6162328E-04	0.31357003E-05	0.61623219E-04	9.2139	0.904677E 14	73.4986	-149.2111
NO		0.5855678E-02	0.29794609E-03	0.58556711E-02	9.1320	0.859658E 16	73.4694	-300.9470
NO2		0.4511218E-07	0.22955294E-08	0.45112064E-07	13.8440	0.662280E 11	91.9367	-383.4463
N+		0.9746348E-09	0.49594311E-10	0.97463429E-09	5.6076	0.143084E 10	50.7565	160.1155
N2O		0.2688658E-06	0.13691201E-07	0.26886487E-06	14.8060	0.394715E 12	89.1181	-354.2329
N2O3		0.	0.	0.	25.7120	0.	138.6374	-547.3361
N2O4		0.	0.	0.	31.6360	0.	150.8771	-590.2066
N2O5		0.	0.	0.	37.5670	0.	167.9909	-654.9452
N2+		0.1979548E-08	0.10072921E-09	0.19795445E-08	9.0744	0.290613E 10	68.3342	0.5388
N2		0.4927095E-00	0.24562658E-01	0.48270879E-00	9.0740	0.708654E 18	68.3452	-297.8356
O-		0.1713778E-06	0.87205449E-08	0.17137736E-06	5.2102	0.251595E 12	52.6945	-151.1706
O+		0.5036298E-07	0.25627207E-08	0.50362945E-07	5.2102	0.739367E 11	52.6945	73.9674
O2-		0.1833868E-10	0.93315917E-12	0.18338573E-10	10.1560	0.269225E 08	73.0260	-259.8138
O2+		0.3657658E-12	0.18612117E-13	0.36576790E-12	10.1560	0.536976E 06	73.0260	-7.9458
O2		0.2811338E-03	0.14305487E-04	0.28113343E-03	10.1560	0.412726E 15	73.0190	-317.7274
O3		0.4161538E-10	0.21179983E-11	0.41615336E-10	13.8723	0.610946E 08	92.8621	-360.9576
C	SOLID	0.	0.	0.	6.3920	0.	15.2979	42.5701

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 4500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 3.4978
SYSTEM ENTROPY (CAL/GM-DEG) 3.1045
SYSTEM GAS CP 0.38094

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.23[illegible]E-00	0.11945839E-01	0.23886579E-00	4.9680	0.389637E 18	40.8766	-76.2467
C	0.64[illegible]E-05	0.32037342E-06	0.64061005E-05	5.4140	0.104496E 14	51.4325	53.1530
N	0.63129[illegible]E-02	0.31571678E-03	0.63129875E-02	5.3960	0.102977E 17	50.1777	-89.7688
O	0.11[illegible]E-00	0.5548B814E-02	0.11095393E-00	5.1500	0.180968E 18	52.1486	-151.9288
E	0.20317[illegible]E-04	0.10161071E-05	0.20317904E-04	4.9680	0.331424E 14	18.4724	-0.7697
CHNO	0.3412[illegible]E-08	0.17063665E-09	0.34120043E-08	19.5360	0.556565E 10	100.7519	-275.1463
CHN	0.66[illegible]E-06	0.33356581E-07	0.66698419E-06	15.7080	0.108799E 13	82.1056	-150.7324
CHO	0.3729[illegible]E-05	0.1A149661E-06	0.[illegible]2467E-05	13.6880	0.526754E 13	84.4675	-201.3630
CH	0.34[illegible]E-07	0.17200745E-08	0.[illegible]E-07	9.3680	0.561036E 11	65.3433	10.8459
HNO	0.93[illegible]E-07	0.46[illegible]E-08	0.[illegible]E-07	14.6481	0.153251E 12	79.8533	-251.0100
HN	0.78158[illegible]E-04	0.39087349E-05	0.78158007E-04	9.3000	0.127491E 15	64.6268	-139.5473
OH-	0.78[illegible]E-05	0.39021672E-06	0.78026681E-06	9.1430	0.127277E 11	64.9930	-191.0796
HO	0.41529[illegible]E-02	0.20769274E-03	0.41529680E-02	9.1430	0.677431E 16	65.0183	-211.6009
CH2O	0.33701[illegible]E-09	0.16[illegible]E-10	0.33701850E-09	14.4790	0.549744E 09	92.7046	-208.4316
CH2	0.15[illegible]E-08	0.73092769E-10	0.15815181E-08	14.5140	0.257977E 10	74.0710	-50.6665
C2H2	0.[illegible]E-12	0.26578394E-13	0.53145438E-12	21.8350	0.866907E 06	93.6231	-32.9261
H2N	0.12073[illegible]E-06	0.60378589E-08	0.12073134E-06	13.4960	0.196937E 12	73.8871	-170.7136
H2O	0.11277[illegible]E-03	0.56400347E-05	0.11277661E-03	14.0300	0.183961E 15	73.9729	-268.4035
H2	0.48[illegible]E-02	0.24100371E-03	0.[illegible]E-02	9.5550	0.786081E 16	52.1943	-130.3919
CH3	0.20375[illegible]E-11	0.10189951E-12	0.2[illegible]E-11	19.3180	0.332365E 07	84.1578	-80.2100
H3N	0.6138[illegible]E-09	0.30698613E-10	0.6138[illegible]E-09	19.1570	0.100130E 10	83.6382	-212.5336
H3O+	0.27300[illegible]E-10	0.13653234E-11	0.27300639E-10	19.1576	0.445327E 08	83.6462	-123.8368
CH4	0.39774[illegible]E-14	0.19891546E-15	0.39774598E-14	25.0897	0.648802E 04	92.6288	-113.4694
C2H4O	0.	0.	0.	36.9150	0.	132.0052	-144.7494
C2H4	0.	0.	0.	31.0100	0.	114.2025	-64.4602
CH6	0.	0.	0.	25.0900	0.	92.6175	-43.9473
CN-	0.15[illegible]E-08	0.78012868E-10	0.15599242E-08	10.9328	0.254454E 10	71.2532	-104.8915
CN	0.20457[illegible]E-04	0.10231008E-05	0.20457648E-04	9.0500	0.333705E 14	70.2953	-92.2948
CO+	0.48957[illegible]E-09	0.24484150E-10	0.48957846E-09	9.0593	0.798599E 09	69.0118	63.7176

CO		0.12611[illegible]E-00	0.63072449E-02	0.12611794E-00	9.0590	0.205723E 16	69.0105	-206.8597
CO2+		0.[illegible]E-11	0.32[illegible]E-12	0.[illegible]E-11	15.2907	0.105193E 08	86.0458	-69.2390
CO2		0.[illegible]E-03	0.16546866E-04	0.33366606E-03	15.2160	0.544275E 15	85.9487	-325.3771
C-		0.[illegible]E-11	0.13[illegible]E-12	0.[illegible]E-11	5.4141	0.427207E 07	51.4323	87.3128
C+		0.49[illegible]E-10	0.24558930E-11	0.49107374E-10	4.9691	0.801038E 08	50.4464	255.8719
C2N2		0.[illegible]E-11	0.10173519E-12	0.20342694E-11	20.6760	0.331430E 07	106.8916	-136.9560
C2+		0.	0.	0.	9.1479	0.	71.6830	310.2645
C2		0.[illegible]E-09	0.76144949E-11	0.15225738E-09	9.8550	0.248362E 09	72.4805	94.5816
C3O2		0.	0.	0.	26.5880	0.	123.4524	-178.1638
C3		0.26[illegible]42E-14	0.13059401E-15	0.26114226E-14	14.7810	0.425975E 04	85.4711	138.9276
C4N2		0.	0.	0.	32.4970	0.	146.1792	-29.0221
C4		0.	0.	0.	20.6960	0.	107.0310	211.5781
C5		0.	0.	0.	26.6060	0.	122.3818	258.0950
NO+		0.20424[illegible]E-04	0.10214408E-05	0.20424455E-04	9.1609	0.333153E 14	72.5306	-112.6995
NO		0.[illegible]E-02	0.44804164E-03	0.89189282E-02	9.0970	0.145485E 17	72.5094	-264.4495
NO2		0.15173[illegible]E-06	0.75842164E-08	0.15173142E-06	13.8260	0.247505E 12	90.4787	-337.8359
N+		0.14746[illegible]E-10	0.73749181E-12	0.14746687E-10	5.3962	0.240548E 08	50.1776	185.3506
N2O		0.40353[illegible]E-06	0.20181101E-07	0.40353584E-06	14.7830	0.658247E 12	87.5592	-310.0571
N2O3		0.134447E-14	0.67237896E-16	0.13444708E-14	25.6840	0.219130E 04	135.9291	-478.6800
N2O4		0.	0.	0.	31.5980	0.	147.5460	-515.5872
N2O5		0.	0.	0.	37.5230	0.	164.0351	-571.9214
N2+		0.[illegible]E-10	0.43229263E-11	0.86440066E-10	9.0306	0.141001E 09	67.3604	34.4717
N2		0.49[illegible]E-00	0.24917982E-01	0.49825324E-00	9.0300	0.812749E 18	67.3918	-263.8991
O-		0.101343E-06	0.50682399E-08	0.10134315E-06	5.1496	0.165311E 12	52.1488	-124.9577
O+		0.33968[illegible]E-08	0.16988089E-09	0.33968923E-08	5.1496	0.554100E 10	52.1488	100.1803
O2-		0.289273E-10	0.14466755E-11	0.26927334E-10	10.0600	0.471862E 08	71.9609	-223.5631
O2+		0.48[illegible]52E-13	0.24407795E-14	0.48805168E-13	10.0600	0.796109E 05	71.9609	28.3049
O2		0.1008[illegible]E-02	0.50420402E-04	0.10081927E-02	10.0620	0.164456E 16	71.9539	-281.4804
O3		0.1[illegible]6170E-09	0.98105890E-11	0.19616988E-09	13.8633	0.319992E 09	91.4010	-314.8855
C	SOLID	0.	0.	0.	6.2990	0.	14.6294	50.0555

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 4000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 3.1082
SYSTEM ENTROPY (CAL/GM-DEG) 3.0123
SYSTEM GAS CP 0.37781

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.209161E-00	0.10112766E-01	0.20916134E-00	4.9680	0.383831E 18	40.2918	-55.9529
C	0.199011E-06	0.96220277E-08	0.19901145E-06	5.3450	0.365205E 12	50.7991	78.7118
N	0.126674E-02	0.61245720E-04	0.12667391E-02	5.2130	0.232459E 16	49.5536	-64.8318
O	0.923056E-01	0.44628943E-02	0.92305601E-01	5.0910	0.169390E 18	51.5458	-126.0030
E	0.485425E-05	0.23469879E-06	0.48542520E-05	4.9680	0.890802E 13	17.8872	8.3230
CHNO	0.654117E-08	0.31625988E-09	0.65411719E-08	19.4510	0.120037E 11	98.4562	-225.3355
CHN	0.275713E-06	0.13330497E-07	0.27571335E-06	15.5330	0.505961E 12	80.2658	-110.1319
CHO	0.455808E-05	0.22037921E-06	0.45580813E-05	13.6310	0.836452E 13	82.8779	-159.5119
CH	0.316171E-08	0.15286610E-09	0.31617144E-08	9.2730	0.580205E 10	64.2455	43.2482
HNO	0.288903E-06	0.13968204E-07	0.28890298E-06	14.5826	0.530165E 12	78.1318	-211.5056
HN	0.498301E-04	0.24092411E-05	0.49830094E-04	9.1990	0.914431E 14	63.5376	-107.5025
OH-	0.145868E-07	0.70525979E-09	0.14586818E-07	9.0461	0.267682E 11	63.9218	-158.8462
HO	0.139183E-01	0.67293926E-03	0.13918336E-01	9.0460	0.255415E 17	63.9467	-179.3546
CH2O	0.123895E-08	0.59902074E-10	0.12389486E-08	19.3790	0.227359E 10	90.4153	-162.6378
CH2	0.783053E-09	0.37859907E-10	0.78305271E-09	14.4160	0.143698E 10	72.3667	-14.0479
C2H2	0.100239E-12	0.48464682E-14	0.10023902E-12	21.5570	0.183948E 06	91.0670	13.2616
H2N	0.261480E-06	0.12642317E-07	0.26147978E-06	13.3930	0.479841E 12	72.3038	-134.1634
H2O	0.187664E-02	0.90733721E-04	0.18766365E-02	13.8500	0.344381E 16	72.3301	-231.8173
H2	0.173849E-01	0.84054305E-03	0.17384868E-01	9.3420	0.319029E 17	51.0619	-104.5700
CH3	0.318683E-11	0.15408056E-12	0.31868331E-11	19.1750	0.584815E 07	81.8901	-38.6856
H3N	0.510804E-08	0.24696915E-09	0.51080384E-08	18.9800	0.937375E 10	81.3920	-171.2671
H3O+	0.174423E-09	0.84332102E-11	0.17442325E-09	18.9806	0.320084E 09	81.3999	-82.5651
CH4	0.230015E-13	0.11121000E-14	0.23001453E-13	24.9011	0.422099E 05	89.6844	-67.8776
C2H4O	0.	0.	0.	36.7010	0.	127.6685	-79.8074
C2H4	0.	0.	0.	30.8110	0.	110.5615	-8.2533
CH6	0.	0.	0.	24.9010	0.	89.6729	1.6394
CN-	0.126538E-09	0.61180138E-11	0.12653827E-09	10.7584	0.232210E 09	69.9750	-69.5792
CN	0.197802E-05	0.95635679E-07	0.19780232E-05	9.0120	0.362986E 13	69.2310	-57.4050
CO+	0.153915E-10	0.74416482E-12	0.15391487E-10	9.0143	0.282449E 08	67.9473	97.9529

CO		0.129183E-00	0.62459069E-02	0.12918347E-00	9.0140	0.237064E 18	67.9461	-172.6154
CO2+		0.119386E-11	0.57722013E-13	0.11938586E-11	15.1959	0.219085E 07	84.2459	-26.6572
CO2		0.163860E-02	0.79224793E-04	0.16385985E-02	15.1190	0.300699E 16	84.1625	-282.8417
C-		0.374380E-13	0.18100920E-14	0.37437952E-13	5.3450	0.687023E 05	50.7986	112.8733
C+		0.125417E-12	0.62088605E-14	0.12841724E-12	4.9686	0.235658E 06	49.8611	280.9518
C2N2		0.822278E-13	0.39756425E-14	0.82227820E-13	20.6290	0.150896E 06	104.4591	-84.1074
C2+		0.	0.	0.	9.1084	0.	70.6079	345.8423
C2		0.116622E-11	0.56385717E-13	0.11662202E-11	9.8360	0.214013E 07	71.3209	130.5357
C3O2		0.	0.	0.	26.5260	0.	120.3244	-117.2050
C3		0.	0.	0.	14.7480	0.	83.6673	181.4161
C4N2		0.	0.	0.	32.4210	0.	142.3556	43.1308
C4		0.	0.	0.	20.6520	0.	104.5957	264.4972
C5		0.	0.	0.	26.5490	0.	119.2510	318.5192
NO+		0.491112E-05	0.23744851E-06	0.49111240E-05	9.1051	0.901239E 13	71.4549	-76.6979
NO		0.132868E-01	0.64240561E-03	0.13286811E-01	9.0580	0.243826E 17	71.4402	-228.4572
NO2		0.553775E-06	0.26000193E-07	0.53775942E-06	13.8070	0.986841E 12	88.8515	-292.9968
N+		0.852635E-13	0.41224128E-14	0.85263456E-13	5.2126	0.156467E 06	49.5538	210.2857
N2O		0.593688E-06	0.28704311E-07	0.59368842E-06	14.7520	0.108948E 13	85.8194	-266.7027
N2O3		0.698603E-14	0.33776857E-15	0.69860338E-14	25.6440	0.128201E 05	132.9061	-411.4556
N2O4		0.	0.	0.	31.5470	0.	143.8265	-442.7237
N2O5		0.	0.	0.	37.4610	0.	159.6192	-490.9867
N2+		0.186439E-11	0.90141594E-13	0.18643896E-11	8.9828	0.342134E 07	66.3197	67.9014
N2		0.516010E 00	0.24948627E-01	0.51600997E 00	8.9830	0.946928E 18	66.3313	-230.4648
O-		0.429022E-07	0.20742948E-08	0.42902226E-07	5.0915	0.787298E 11	51.5458	-99.0313
O+		0.112289E-09	0.54290738E-11	0.11228899E-09	5.0915	0.206061E 09	51.5458	126.1067
O2-		0.369252E-10	0.17852986E-11	0.36925154E-10	9.9320	0.677612E 08	70.7834	-187.8717
O2+		0.334799E-14	0.16187213E-15	0.33479853E-14	9.9320	0.614388E 04	70.7634	63.9963
O2		0.389933E-02	0.18852925E-03	0.38993319E-02	9.9320	0.715565E 16	70.7761	-245.7927
O3		0.937409E-09	0.45322910E-10	0.93740926E-09	13.8508	0.172024E 10	89.7688	-269.5851
C	SOLID	0.	0.	0.	6.2130	0.	13.8931	57.1877

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 3500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 2.4451
SYSTEM ENTROPY (CAL/GM-DEG) 2.8343
SYSTEM GAS CP 0.37283

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.123334E-00	0.54548026E-02	0.12333379E-00	4.9680	0.258662E 18	39.6280	-35.9688
C	0.355408E-08	0.15718960E-09	0.35540771E-08	5.2610	0.745380E 10	50.0902	103.9410
N	0.165466E-03	0.73182188E-05	0.16546587E-03	5.0860	0.347024E 15	48.8672	-40.2256
O	0.480226E-01	0.21239408E-02	0.48022576E-01	5.0410	0.100716E 18	50.8700	-100.3979
E	0.642517E-06	0.28417236E-07	0.64251737E-06	4.9680	0.134752E 13	17.2239	17.1045
CHNO	0.109951E-07	0.48629239E-09	0.10995133E-07	19.3310	0.230596E 11	95.8659	-176.7389
CHN	0.988791E-07	0.43732198E-08	0.98879065E-07	15.3260	0.207375E 12	78.2046	-70.5010
CHO	0.499933E-05	0.22111022E-06	0.49993304E-05	13.5500	0.104849E 14	81.0535	-118.5188
CH	0.157958E-09	0.69861825E-11	0.15795849E-09	9.1640	0.331279E 09	63.0143	75.0712
HNO	0.577574E-06	0.25544924E-07	0.57757402E-06	14.4891	0.121132E 13	76.1905	-172.9147
HN	0.199336E-04	0.88162354E-06	0.19933622E-04	9.0810	0.418059E 14	62.3168	-76.0310
OH-	0.118781E-07	0.52534556E-09	0.11878131E-07	8.9281	0.249115E 11	62.7215	-127.1792
HO	0.301041E-01	0.13314448E-02	0.30104139E-01	8.9290	0.631360E 17	62.7464	-147.6751
CH2O	0.327781E-08	0.14497069E-09	0.32778060E-08	19.2350	0.687439E 10	87.8370	-118.0621
CH2	0.238936E-09	0.10567660E-10	0.23893615E-09	14.2780	0.501110E 09	70.4504	21.6671
C2H2	0.139484E-13	0.61690978E-15	0.13948409E-13	21.2250	0.292534E 05	88.2102	58.0951
H2N	0.350697E-06	0.15484071E-07	0.35009684E-06	13.2490	0.734242E 12	70.5245	-98.4432
H2O	0.222618E-01	0.98459420E-03	0.22261801E-01	13.6170	0.466887E 17	70.4959	-196.1015
H2	0.440257E-01	0.19471691E-02	0.44025745E-01	9.1100	0.923332E 17	49.8494	-79.3294
CH3	0.298009E-11	0.13180352E-12	0.29800946E-11	18.9760	0.625002E 07	79.3423	1.6357
H3N	0.271571E-07	0.12011053E-08	0.27157146E-07	18.7310	0.569554E 11	78.8731	-131.1867
H3O+	0.530690E-09	0.23471324E-10	0.53068967E-09	18.7314	0.111299E 10	78.8814	-42.4822
CH4	0.813688E-13	0.35987762E-14	0.81368793E-13	24.6325	0.170651E 06	86.3766	-23.8454
C2H4O	0.	0.	0.	36.3960	0.	122.7879	-17.1707
C2H4	0.	0.	0.	30.5280	0.	106.4649	46.0269
CH6	0.	0.	0.	24.6330	0.	86.3651	45.6652
CN-	0.638797E-11	0.28252669E-12	0.63879650E-11	10.4642	0.133972E 08	68.5569	-34.9397
CN	0.154577E-06	0.68366177E-08	0.15457680E-06	8.9660	0.324187E 12	68.0307	-23.0831
CO+	0.227895E-12	0.10079349E-13	0.22789538E-12	8.9615	0.477954E 06	66.7472	131.6425

CO		0.1345[illegible]E 00	0.59498754E-02	0.13450484E 00	8.9610	0.282091E 16	66.7466	-138.9385
CO2+		0.1135[illegible]E-12	0.50241313E-14	0.1135[illegible]5FE-12	15.0858	0.238239E 06	82.2197	14.9701
CO2		0.[illegible]01E-02	0.37636269E-0[illegible]	0.[illegible]07608[illegible]E-02	15.0060	0.178468E 17	82.1516	-241.2538
C-		0.	0.	0.	5.2612	0.	50.0904	138.0990
C+		0.	0.	0.	4.9685	0.	49.1977	305.7199
C2N2		0.33733[illegible]E-14	0.14919681E-15	0.33733591E-14	20.5590	0.707479E 04	101.7087	-32.5496
C2+		0.	0.	0.	9.0637	0.	69.3946	380.8494
C2		0.529926E-14	0.23437562E-15	0.52992629E-14	9.7820	0.111139E 05	70.0103	165.8775
C3O2		0.	0.	0.	26.4360	0.	116.7880	-57.9078
C3		0.	0.	0.	14.7000	0.	81.6649	222.9749
C4N2		0.	0.	0.	32.3120	0.	138.0333	113.2515
C4		0.	0.	0.	20.5880	0.	101.8426	316.1204
C5		0.	0.	0.	26.4650	0.	115.7119	377.2770
NO+		0.661351E-06	0.29250209E-07	0.66135099E-06	9.0458	0.138702E 13	70.2430	-41.2570
NO		0.148832E-01	0.65825292E-03	0.14883183E-01	9.0120	0.312138E 17	70.2341	-193.0344
NO2		0.120545E-05	0.53314794E-07	0.12054543E-05	13.7750	0.252814E 13	87.0102	-249.0218
N+		0.	0.	0.	5.0855	0.	48.8670	234.8940
N2O		0.676519E-06	0.29921042E-07	0.67651862E-06	14.7070	0.141383E 13	83.8521	-224.2734
N2O3		0.176218E-13	0.77937660E-15	0.17621805E-13	25.5870	0.369574E 05	129.4655	-345.8393
N2O4		0.	0.	0.	31.4720	0.	139.6190	-371.8399
N2O5		0.	0.	0.	37.3720	0.	154.6220	-412.3970
N2+		0.176252E-13	0.77952898E-15	0.17625250E-13	8.9268	0.369645E 05	65.1239	100.7587
N2		0.564542E 00	0.24968560E-01	0.56454237E 00	8.9270	0.118399E 19	65.1356	-197.5919
O-		0.746597E-08	0.33020468E-09	0.74659704E-08	5.0412	0.156580E 11	50.8695	-73.4240
O+		0.115787E-11	0.51210117E-13	0.11578673E-11	5.0412	0.242834E 07	50.8695	151.7140
O2-		0.174611E-10	0.77227069E-12	0.17461140E-10	9.7620	0.366204E 08	69.4683	-152.8024
O2+		0.	0.	0.	9.7620	0.	69.4683	99.0656
O2		0.961716E-02	0.42534762E-03	0.96171644E-02	9.7620	0.201696E 17	69.4614	-210.7278
O3		0.197843E-08	0.87501999E-10	0.19784314E-08	13.8326	0.414927E 10	87.9205	-225.1526
C	SOLID	0.	0.	0.	6.1340	0.	13.0686	63.9332

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 3000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 1.7225
SYSTEM ENTROPY (CAL/GM-DEG) 2.6125
SYSTEM GAS CP 0.36732

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.349483E-01	0.13893359E-02	0.34948297E-01	4.9680	0.855114E 17	38.8620	-16.3406
C	0.364495E-10	0.14490166E-11	0.36449546E-10	5.1680	0.891846E 08	49.2870	128.7886
N	0.110149E-04	0.43788728E-06	0.11014913E-04	5.0110	0.269512E 14	48.0900	-15.9822
O	0.847571E-02	0.33694384E-03	0.84757137E-02	5.0040	0.207383E 17	50.0960	-75.1515
E	0.290217E-07	0.11537287E-08	0.29021673E-07	4.9680	0.710101E 11	16.4580	25.5299
CHNO	0.115800E-07	0.46035036E-09	0.11579964E-07	19.1540	0.283338E 11	92.8990	-129.5287
CHN	0.318765E-07	0.12672207E-08	0.31876527E-07	15.0710	0.779954E 11	75.8620	-31.9732
CHO	0.293669E-05	0.11682482E-06	0.29386906E-05	13.4300	0.719038E 13	78.9830	-78.4925
CH	0.361234E-11	0.14360503E-12	0.36123382E-11	9.0330	0.883866E 07	61.6120	106.2340
HNO	0.350835E-06	0.13947093E-07	0.35083461E-06	14.3491	0.858421E 12	73.9673	-135.3619
HN	0.334617E-05	0.13302385E-06	0.33461720E-05	8.9350	0.818740E 13	60.9290	-45.2148
OH-	0.136002E-08	0.54066415E-10	0.13600232E-08	8.7772	0.332770E 10	61.3567	-96.1519
HO	0.201031E-01	0.79917757E-03	0.20103053E-01	8.7780	0.491881E 17	61.3820	-116.6361
CH2O	0.360437E-08	0.14328811E-09	0.36043662E-08	19.0190	0.881915E 10	84.8880	-74.8631
CH2	0.349993E-10	0.13913644E-11	0.34999322E-10	14.0760	0.856362E 08	68.2640	56.3594
C2H2	0.160673E-14	0.63874108E-16	0.16067325E-14	20.8200	0.393135E 04	84.9690	101.4080
H2N	0.166910E-06	0.66353417E-08	0.16690987E-06	13.0370	0.408396E 12	68.4980	-63.6764
H2O	0.821468E-01	0.32656658E-02	0.82146768E-01	13.3040	0.200996E 18	68.4210	-161.3637
H2	0.494392E-01	0.19654065E-02	0.49439167E-01	8.8590	0.120968E 18	48.4650	-54.7442
CH3	0.110996E-11	0.44125382E-13	0.11099597E-11	18.6780	0.271585E 07	76.4390	40.5978
H3N	0.469476E-07	0.18663549E-08	0.46947557E-07	18.3670	0.114871E 12	76.0130	-92.4500
H3O+	0.290280E-09	0.11539800E-10	0.29027996E-09	18.3671	0.710256E 09	76.0209	-3.7406
CH4	0.103221E-12	0.41034359E-14	0.10322060E-12	24.2333	0.252560E 06	82.6088	18.4226
C2H4O	0.	0.	0.	35.9410	0.	117.2110	42.8622
C2H4	0.	0.	0.	30.1070	0.	101.7900	98.1178
CH6	0.	0.	0.	24.2330	0.	82.5970	87.9290
CN-	0.166026E-12	0.66002014E-14	0.16602593E-12	10.0402	0.406232E 06	66.9760	-1.0491
CN	0.112089E-07	0.44560026E-09	0.11208930E-07	8.9060	0.274260E 11	66.6540	10.5934
CO+	0.119736E-14	0.47599982E-16	0.11973622E-14	8.8953	0.292970E 04	65.3708	164.6804

CO		0.129331E-00	0.51414324E-02	0.12933107E-00	6.8950	0.316447E 18	55.3700	-105.9009
CO2+		0.304949E-14	0.12122956E-15	0.30494905E-14	14.9495	0.746148E 04	79.9014	55.5146
CO2		0.297811E-01	0.11839198E-02	0.29781119E-01	14.8730	0.728663E 17	79.8480	-200.7385
C-		0.	0.	0.	5.1677	0.	49.2868	162.9479
C+		0.	0.	0.	4.9686	0.	48.4318	330.1323
C2N2		0.	0.	0.	20.4540	0.	98.5480	17.5318
C2+		0.	0.	0.	9.0102	0.	68.0015	415.2071
C2		0.	0.	0.	9.6760	0.	68.5100	200.5162
C3O2		0.	0.	0.	26.3000	0.	112.7230	-0.5053
C3		0.	0.	0.	14.6260	0.	79.3450	263.4338
C4N2		0.	0.	0.	32.1480	0.	133.0640	181.0580
C4		0.	0.	0.	20.4910	0.	98.6760	366.2704
C5		0.	0.	0.	26.3380	0.	111.6410	434.1420
NO+		0.302954E-07	0.12039655E-08	0.30285362E-07	8.9773	0.741021E 11	68.8539	-6.4844
NO		0.723827E-02	0.28775062E-03	0.72382739E-02	8.9550	0.177106E 17	68.8490	-158.2537
NO2		0.622082E-06	0.24730261E-07	0.62208171E-06	13.7280	0.152211E 13	84.8900	-206.0333
N+		0.	0.	0.	5.0105	0.	48.0697	259.1377
N2O		0.340890E-06	0.13551770E-07	0.34089041E-06	14.6380	0.834089E 12	81.5900	-182.8979
N2O3		0.460563E-14	0.18309238E-15	0.46056296E-14	25.5000	0.112690E 05	125.5480	-282.0570
N2O4		0.	0.	0.	31.3570	0.	134.7760	-303.2106
N2O5		0.	0.	0.	37.2350	0.	148.8720	-336.4901
N2+		0.	0.	0.	8.8556	0.	63.7531	132.9965
N2		0.632833E 00	0.25157686E-01	0.63283345E 00	8.8550	0.154841E 19	63.7650	-165.3584
O-		0.193079E-09	0.76756671E-11	0.19307893E-09	5.0042	0.472425E 09	50.0955	-48.1780
O+		0.173846E-14	0.69110730E-16	0.17384581E-14	5.0042	0.425365E 04	50.0955	176.9500
O2-		0.719700E-12	0.28610970E-13	0.71969972E-12	9.5510	0.176096E 07	67.9797	-118.4322
O2+		0.	0.	0.	9.5510	0.	67.9797	133.4358
O2		0.568417E-02	0.22596885E-03	0.56841734E-02	9.5510	0.139080E 17	67.9730	-176.3621
O3		0.396251E-09	0.15752582E-10	0.39625111E-09	13.8047	0.969546E 09	85.7902	-181.7114
C	SOLID	0.	0.	0.	6.0570	0.	12.1290	70.2386

4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 2500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 1.3368
SYSTEM ENTROPY (CAL/GM-DEG) 2.4737
SYSTEM GAS CP 0.36164

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.544222E-02	0.20756491E-03	0.54422185E-02	4.9680	0.159792E 17	37.9568	2.8692
C	0.212695E-12	0.81121214E-14	0.21269459E-12	5.0770	0.624504E 05	46.3539	153.2037
N	0.236729E-06	0.90287846E-08	0.23672891E-06	4.9780	0.695073E 12	47.1802	7.8421
O	0.208251E-03	0.79426256E-05	0.20825053E-03	4.9840	0.611456E 15	49.1854	-50.3238
E	0.229060E-09	0.86981390E-11	0.22805960E-09	4.9680	0.669618E 09	15.5523	33.5393
CHNO	0.105279E-07	0.40153257E-09	0.10527925E-07	18.8780	0.309116E 11	89.4311	-83.9235
CHN	0.201102E-07	0.76699986E-09	0.20110242E-07	14.7330	0.590468E 11	73.1437	5.2986
CHO	0.122301E-05	0.46645185E-07	0.12230067E-05	13.2400	0.359094E 13	76.5515	-39.5937
CH	0.577965E-13	0.22043446E-14	0.57796496E-13	6.8640	0.169700E 06	59.9800	136.6443
HNO	0.417703E-07	0.15931100E-08	0.41770320E-07	14.1275	0.122644E 12	71.3703	-99.0095
HN	0.234445E-06	0.89416592E-08	0.23444454E-06	8.7430	0.688366E 12	59.3170	-15.1422
OH-	0.897643E-11	0.34235902E-12	0.89764331E-11	6.5739	0.263562E 08	59.7745	-65.8587
HO	0.283666E-02	0.10818952E-03	0.28366596E-02	8.5730	0.832887E 16	59.7999	-86.3312
CH2O	0.330994E-08	0.12624036E-09	0.33099409E-08	18.6770	0.971950E 10	81.4496	-33.2539
CH2	0.687208E-11	0.26209934E-12	0.68720760E-11	13.7640	0.201775E 06	65.7252	89.8727
C2H2	0.822284E-15	0.31361724E-16	0.82228423E-15	20.2820	0.241435E 04	81.2213	142.9785
H2N	0.452263E-07	0.17249209E-08	0.45226314E-07	12.7130	0.132791E 12	66.1493	-29.9994
H2O	0.114454E-00	0.43652607E-02	0.11445432E-00	12.8630	0.336056E 18	66.0338	-127.7336
H2	0.472551E-01	0.18022983E-02	0.47255100E-01	8.5750	0.138748E 18	46.8756	-30.9012
CH3	0.727455E-12	0.27744967E-13	0.72745519E-12	18.2150	0.213592E 07	73.0740	77.9970
H3N	0.706637E-07	0.26950977E-08	0.70663727E-07	17.8100	0.207480E 12	72.7131	-55.2459
H3O+	0.461189E-10	0.17589652E-11	0.46118934E-10	17.8108	0.135412E 09	72.7206	33.4656
CH4	0.345448E-12	0.13175305E-13	0.34544802E-12	23.6077	0.101429E 07	78.2446	58.6643
C2H4O	0.	0.	0.	35.2260	0.	110.7201	99.8891
C2H4	0.	0.	0.	29.4470	0.	96.3585	147.6895
CH6	0.	0.	0.	23.6080	0.	78.2333	124.1532
CN-	0.187229E-14	0.71408571E-16	0.18722667E-14	9.5192	0.549733E 04	65.1934	32.0029
CN	0.943634E-09	0.35989963E-10	0.94363364E-09	8.8230	0.277066E 10	65.0367	43.5298
CO+	0.	0.	0.	8.8040	0.	63.7569	196.9742

CO		0.11[illegible]E-00	0.45236275E-02	0.11860660E-00	8.8040	0.348247E 18	63.7559	-73.6065
CO2+		0.	0.	0.	14.7656	0.	77.1681	94.8062
CO2		0.47241[illegible]E-01	0.18017958E-02	0.47241926E-01	14.6920	0.138710E 18	77.1529	-161.4706
C-		0.	0.	0.	5.0769	0.	48.3533	187.3643
C+		0.	0.	0.	4.9688	0.	47.5259	354.1285
C2N2		0.	0.	0.	20.2850	0.	94.8331	65.9052
C2+		0.	0.	0.	8.9406	0.	66.3650	448.8106
C2		0.	0.	0.	9.4970	0.	66.7617	234.3452
C3O2		0.	0.	0.	26.0820	0.	107.9465	54.6977
C3		0.	0.	0.	14.5060	0.	76.5625	302.7775
C4N2		0.	0.	0.	31.8840	0.	127.2261	246.1716
C4		0.	0.	0.	20.3360	0.	94.9533	414.7047
C5		0.	0.	0.	26.1360	0.	106.8568	488.8008
NO+		0.1[illegible]E-09	0.72443732E-11	0.19109697E-09	8.8909	0.561090E 09	67.2248	27.5472
NO		0.68[illegible]E-03	0.26288550E-04	0.68926886E-03	8.8770	0.202380E 16	67.2230	-124.2235
NO2		0.17[illegible]E-07	0.63123249E-09	0.17861477E-07	13.6500	0.524441E 11	82.3938	-164.1938
N+		0.	0.	0.	4.9777	0.	47.1797	282.9617
N2O		0.32[illegible]E-07	0.12556423E-08	0.32922132E-07	14.5280	0.966645E 11	78.9304	-142.7478
N2O3		0.	0.	0.	25.3590	0.	120.9104	-220.4071
N2O4		0.	0.	0.	31.1710	0.	129.0754	-237.2076
N2O5		0.	0.	0.	37.0120	0.	142.1017	-265.6951
N2+		0.	0.	0.	8.7561	0.	62.1473	164.4830
N2		0.[illegible]E 00	0.25288726E-01	0.66305411E 00	8.7560	0.194683E 19	62.1589	-133.8654
O-		0.17[illegible]E-12	0.67926914E-14	0.17809999E-12	4.9836	0.522929E 06	49.1853	-23.3511
O+		0.	0.	0.	4.9836	0.	49.1853	201.7869
O2-		0.	0.	0.	9.3010	0.	66.2614	-84.8610
O2+		0.	0.	0.	9.3010	0.	66.2614	167.0070
O2		0.[illegible]E-03	0.79954436E-05	0.20963538E-03	9.3010	0.615522E 15	66.2546	-142.7942
O3		0.8[illegible]E-12	0.33718287E-13	0.88407179E-12	13.7589	0.259577E 07	83.2773	-139.4258
C	SOLID	0.	0.	0.	5.9740	0.	11.0325	76.0358

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 2000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 1.1348
SYSTEM ENTROPY (CAL/GM-DEG) 2.3840
SYSTEM GAS CP 0.35322

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.373350E-03	0.14172994E-04	0.37335005E-03	4.9680	0.137027E 16	36.8478	21.5816
C	0.	0.	0.	5.0080	0.	47.2296	177.1097
N	0.732937E-09	0.27823506E-10	0.73293671E-09	4.9690	0.269002E 10	46.0699	31.1659
O	0.407441E-06	0.15467151E-07	0.40744118E-06	4.9780	0.149539E 13	48.0743	-25.9984
E	0.596875E-12	0.22658380E-13	0.59687512E-12	4.9680	0.219065E 07	14.4437	41.0486
CHNO	0.109222E-07	0.41462519E-09	0.10922204E-07	18.4240	0.400866E 11	85.2668	-40.2142
CHN	0.242880E-07	0.92201252E-09	0.24287982E-07	14.2460	0.891416E 11	69.9095	41.0861
CHO	0.393244E-06	0.14928190E-07	0.39324372E-06	12.9210	0.144328E 13	73.6305	-2.0239
CH	0.	0.	0.	8.6240	0.	58.0288	166.1608
HNO	0.937228E-09	0.35578730E-10	0.93722757E-09	13.7508	0.343981E 10	68.2575	-64.0771
HN	0.462815E-08	0.17569224E-09	0.46281474E-08	8.4720	0.169862E 11	57.3948	14.0524
OH-	0.873411E-14	0.33156140E-15	0.87341084E-14	8.2852	0.320559E 05	57.8927	-36.4271
HO	0.823279E-04	0.31253043E-05	0.82327878E-04	8.2850	0.302159E 15	57.9181	-56.8865
CH2O	0.396629E-08	0.14980794E-09	0.39662941E-08	18.0950	0.144837E 11	77.3430	6.4763
CH2	0.159704E-11	0.60626330E-13	0.15970404E-11	13.2600	0.586145E 07	62.7076	122.0033
C2H2	0.184290E-14	0.69959549E-16	0.18428993E-14	19.5040	0.676380E 04	76.7802	182.5118
H2N	0.739564E-08	0.28075092E-09	0.73956404E-08	12.1960	0.271434E 11	63.3680	2.4002
H2O	0.113227E-00	0.42982838E-02	0.11322692E-00	12.2140	0.415565E 18	63.2342	-95.3971
H2	0.531726E-01	0.20165200E-02	0.53172573E-01	8.1950	0.195154E 18	45.0041	-7.9163
CH3	0.113572E-11	0.43113813E-13	0.11357193E-11	17.4380	0.416831E 07	69.0910	113.5690
H3N	0.169395E-06	0.64305355E-08	0.16939545E-06	16.9200	0.621714E 12	68.8338	-19.8345
H3O+	0.591563E-12	0.22456712E-13	0.59156270E-12	16.9206	0.217115E 07	68.8411	68.8838
CH4	0.702840E-11	0.26680987E-12	0.70284004E-11	22.5626	0.257956E 08	73.0872	96.5355
C2H4O	0.	0.	0.	34.0220	0.	102.9865	153.3767
C2H4	0.	0.	0.	28.3440	0.	89.9040	194.3049
CH6	0.	0.	0.	22.5620	0.	73.0759	166.0290
CN-	0.	0.	0.	8.9884	0.	63.1315	64.0982
CN	0.485670E-10	0.18436842E-11	0.48566984E-10	8.6930	0.178250E 09	63.0820	75.5760
CO+	0.	0.	0.	8.6636	0.	61.8074	228.3819

CO		0.113320E-00	0.43018091E-02	0.11331978E-00	8.6640	0.415906E 18	61.8c64	-42.1993
CO2+		0.	0.	0.	14.4874	0.	73.9208	132.6113
CO2		0.533076E-01	0.20236457E-02	0.53307597E-01	14.4240	0.195649E 18	73.9030	-123.6787
C-		0.	0.	0.	5.0078	0.	47.2290	211.2597
C+		0.	0.	0.	4.9691	0.	46.4171	377.6247
C2N2		0.	0.	0.	19.9930	0.	90.3374	112.2362
C2+		0.	0.	0.	8.8390	0.	64.3608	481.5145
C2		0.	0.	0.	9.2320	0.	64.6710	267.2214
C3O2		0.	0.	0.	25.7020	0.	102.1665	107.2754
C3		0.	0.	0.	14.2920	0.	73.1525	340.6129
C4N2		0.	0.	0.	34.4260	0.	120.1596	308.0789
C4		0.	0.	0.	20.0640	0.	90.4441	461.0936
C5		0.	0.	0.	25.7810	0.	101.0617	540.8314
NO+		0.140465E-13	0.53322848E-15	0.14046494E-13	8.7666	0.515534E 05	65.2543	60.6839
NO		0.983591E-05	0.37339752E-06	0.98359068E-05	8.7590	0.360997E 14	65.2545	-91.0864
NO2		0.213155E-10	0.80917311E-12	0.21315525E-10	13.5100	0.782321E 08	79.3619	-123.7272
N+		0.	0.	0.	4.9691	0.	46.0703	306.2844
N2O		0.479753E-09	0.18212226E-10	0.47975294E-09	14.3350	0.176079E 10	75.7089	-104.0600
N2O3		0.	0.	0.	25.1080	0.	115.2780	-161.3109
N2O4		0.	0.	0.	30.8370	0.	122.1542	-174.3382
N2O5		0.	0.	0.	36.6130	0.	133.8840	-194.6257
N2+		0.	0.	0.	8.6009	0.	60.2101	190.0366
N2		0.666506E 00	0.25301694E-01	0.66650623E 00	8.6010	0.244621E 19	60.2221	-103.2546
O-		0.	0.	0.	4.9778	0.	48.0742	0.9741
O+		0.	0.	0.	4.9778	0.	48.0742	226.1121
O2-		0.	0.	0.	9.0240	0.	64.2172	-52.2248
O2+		0.	0.	0.	9.0240	0.	64.2172	199.6432
O2		0.376514E-06	0.14293084E-07	0.37651351E-06	9.0240	0.138188E 13	64.2107	-110.1514
O3		0.	0.	0.	13.6757	0.	80.2157	-98.5249
C	SOLID	0.	0.	0.	5.8650	0.	9.7111	81.2335

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 1500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 0.9575
SYSTEM ENTROPY (CAL/GM-DEG) 2.2820
SYSTEM GAS CP 0.33998

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.443321E-05	0.16825323E-06	0.44332130E-05	4.9680	0.216943E 14	35.4190	39.6649
C	0.	0.	0.	4.9750	0.	45.7940	200.3836
N	0.494529E-13	0.18768799E-14	0.49452991E-13	4.9680	0.242002E 06	44.6410	53.8603
O	0.121417E-10	0.46081387E-12	0.12141734E-10	4.9820	0.594167E 08	46.6420	-2.3025
E	0.	0.	0.	4.9680	0.	13.0145	47.9303
CHNO	0.119989E-07	0.45159724E-09	0.11898890E-07	17.6220	0.582283E 11	80.0760	1.1742
CHN	0.362044E-07	0.13740618E-08	0.36204409E-07	13.4790	0.177170E 12	65.9170	75.0823
CHO	0.580218E-07	0.22020964E-08	0.58021845E-07	12.3410	0.283935E 12	69.9920	33.9184
CH	0.	0.	0.	8.2520	0.	55.5990	194.5935
HNO	0.163743E-11	0.62145074E-13	0.16374268E-11	13.0515	0.801290E 07	64.3960	-30.8758
HN	0.663611E-11	0.25185936E-12	0.66361057E-11	8.0650	0.324744E 08	55.0150	42.1777
OH-	0.	0.	0.	7.8662	0.	55.5688	-8.0389
HO	0.211135E-06	0.80131781E-08	0.21113488E-06	7.8660	0.103321E 13	55.5940	-28.4851
CH2O	0.537819E-08	0.20411786E-09	0.53781907E-08	17.0130	0.263187E 11	72.2640	43.9298
CH2	0.147457E-12	0.55964274E-14	0.14745723E-12	12.4040	0.721596E 06	59.0110	152.4669
C2H2	0.830833E-14	0.31532493E-15	0.83083255E-14	18.2910	0.406576E 05	71.3380	219.5940
H2N	0.351317E-09	0.13333510E-10	0.35131741E-09	11.3400	0.171920E 10	59.9780	33.2676
H2O	0.102615E-00	0.38945524E-02	0.10261545E-00	11.2330	0.502158E 18	59.8590	-64.5952
H2	0.640475E-01	0.24307876E-02	0.64047504E-01	7.7200	0.313422E 18	42.7160	14.0348
CH3	0.250142E-11	0.94936105E-13	0.25014199E-11	16.0530	0.122409E 08	64.2630	146.9493
H3N	0.721080E-06	0.27367070E-07	0.72108006E-06	15.4420	0.352867E 13	64.1710	13.4545
H3O+	0.	0.	0.	15.4433	0.	64.1780	102.1768
CH4	0.115910E-08	0.43991239E-10	0.11591013E-08	20.6881	0.567217E 10	66.8514	131.5726
C2H4O	0.	0.	0.	31.8260	0.	93.4970	202.5837
C2H4	0.	0.	0.	26.3610	0.	82.0190	237.3573
CH6	0.	0.	0.	20.6880	0.	66.8400	201.0600
CN-	0.	0.	0.	8.5221	0.	60.6174	95.0599
CN	0.356262E-12	0.13521154E-13	0.35626156E-12	8.4630	0.174340E 07	60.6120	106.5274
CO+	0.	0.	0.	8.4175	0.	59.3485	258.6974

CO		0.10261E[illegible]-00	0.38945550E-02	0.10261551E-00	8.4170	0.502159E 18	59.3480	-11.8849
CO2+		0.	0.	0.	14.0012	0.	69.8183	168.5895
CO2		0.64[illegible]50[illegible]E-01	0.24303123E-02	0.64050791E-01	13.9530	0.313438E 18	69.8170	-87.7050
C-		0.	0.	0.	4.9747	0.	45.7942	234.5423
C+		0.	0.	0.	4.9698	0.	44.9875	400.4929
C2N2		0.	0.	0.	19.4340	0.	84.6600	156.0478
C2+		0.	0.	0.	8.6634	0.	61.8618	513.1032
C2		0.	0.	0.	8.9070	0.	62.0630	298.9327
C3O2		0.	0.	0.	24.9600	0.	94.8710	156.6142
C3		0.	0.	0.	13.8620	0.	68.9180	376.5488
C4N2		0.	0.	0.	30.5420	0.	111.2370	366.0245
C4		0.	0.	0.	19.5300	0.	84.7430	504.9529
C5		0.	0.	0.	25.0830	0.	93.7390	589.6095
NO+		0.	0.	0.	8.5554	0.	62.7611	92.7150
NO		0.[illegible]E-08	0.29739[illegible]50E-09	0.78357547E-08	8.5520	0.383450E 11	62.7630	-59.0552
NO2		0.	0.	0.	13.2270	0.	75.5130	-84.9658
N+		0.	0.	0.	4.9681	0.	44.6410	328.9793
N2O		0.41592[illegible]E-12	0.15[illegible]5670E-13	0.41592807E-12	13.9580	0.203538E 07	71.6350	-67.1794
N2O3		0.	0.	0.	24.5990	0.	108.1230	-105.3815
N2O4		0.	0.	0.	30.1580	0.	113.3730	-115.3591
N2O5		0.	0.	0.	35.7960	0.	123.4590	-130.1756
N2+		0.	0.	0.	8.3296	0.	57.7726	224.6105
N2		0.666665E 00	0.25301871E-01	0.66666527E 00	8.3300	0.326239E 19	57.7840	-73.7254
O-		0.	0.	0.	4.9822	0.	46.6417	24.6702
O+		0.	0.	0.	4.9822	0.	46.6417	249.8082
O2-		0.	0.	0.	8.7380	0.	61.6628	-20.7277
O2+		0.	0.	0.	8.7380	0.	61.6628	231.1403
O2		0.[illegible]751E-11	0.34527659E-12	0.90975057E-11	8.7380	0.445195E 08	61.6560	-78.6671
O3		0.	0.	0.	13.5014	0.	76.3043	-59.3501
C	SOLID	0.	0.	0.	5.6690	0.	8.0500	85.6906

PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 1000.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 0.7844
SYSTEM ENTROPY (CAL/GM-DEG) 2.1417
SYSTEM GAS CP 0.31856

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.68C738E-09	0.25834088E-10	0.68073848E-09	4.9680	0.499689E 10	33.4044	56.9048
C	0.	0.	0.	4.9690	0.	43.7786	222.8110
N	0.	0.	0.	4.9680	0.	42.6264	75.7112
O	0.	0.	0.	4.9990	0.	44.6191	20.5476
E	0.	0.	0.	4.9680	0.	11.0001	53.9679
CHNO	0.138506E-07	0.52563166E-09	0.13850603E-07	16.1250	0.101669E 12	73.2220	39.5880
CHN	0.811000E-07	0.30777527E-08	0.81100005E-07	12.1820	0.595306E 12	60.7091	106.8044
CHO	0.112734E-08	0.42782554E-10	0.11273372E-08	11.2160	0.827509E 10	65.2064	67.7792
CH	0.	0.	0.	7.6540	0.	52.3737	221.6304
HNO	0.	0.	0.	11.6254	0.	59.3767	0.1275
HN	0.	0.	0.	7.4720	0.	51.8675	68.9425
OH-	0.	0.	0.	7.3299	0.	52.4944	19.0195
HO	0.132118E-11	0.50138947E-13	0.13211811E-11	7.3290	0.969798E 07	52.5201	-1.4142
CH2O	0.939308E-08	0.35646835E-09	0.93930825E-08	14.8170	0.689489E 11	65.8059	78.5242
CH2	0.117266E-14	0.44502424E-16	0.11726565E-14	10.9680	0.860776E 04	54.2692	180.8426
C2H2	0.167165E-12	0.63439424E-14	0.16716540E-12	16.3180	0.122706E 07	64.3170	253.5919
H2N	0.737536E-12	0.27989551E-13	0.73753580E-12	9.9920	0.541380E 07	55.6550	62.2249
H2O	0.757217E-01	0.28736470E-02	0.75721738E-01	9.8510	0.555827E 18	55.5919	-35.6837
H2	0.908788E-01	0.34488604E-02	0.90878842E-01	7.2190	0.667086E 18	39.7029	34.6823
CH3	0.109405E-10	0.41519404E-12	0.10940527E-10	13.4860	0.803077E 08	58.2581	177.6354
H3N	0.121972E-04	0.46288654E-06	0.12197243E-04	13.0430	0.895325E 14	58.3935	44.1527
H3O+	0.	0.	0.	13.0456	0.	58.4003	132.8775
CH4	0.298729E-04	0.11336789E-05	0.29872889E-04	17.1600	0.219279E 15	59.1518	163.1426
C2H4O	0.	0.	0.	27.4770	0.	81.4283	246.4445
C2H4	0.737916E-11	0.28003978E-12	0.73791593E-11	22.5740	0.541659E 08	72.0561	275.9817
CH6	0.673676E-13	0.25573641E-14	0.67387559E-13	17.1600	0.494651E 06	59.1401	232.6247
CN-	0.	0.	0.	7.9962	0.	57.2681	124.5787
CN	0.	0.	0.	7.9950	0.	57.2708	136.0449
CO+	0.	0.	0.	7.9305	0.	56.0292	287.5895

CO		0.756618E-01	0.28713726E-02	0.75661808E-01	7.9310	0.555387E 18	56.0280	17.0069
CO2+		0.	0.	0.	12.9991	0.	64.3322	202.2023
CO2		0.909869E-01	0.34529609E-02	0.90986890E-01	12.9800	0.667879E 18	64.3431	-54.0882
C-		0.	0.	0.	4.9693	0.	43.7788	256.9694
C+		0.	0.	0.	4.9720	0.	42.9866	422.5103
C2N2		0.	0.	0.	18.2370	0.	77.0075	196.5731
C2+		0.	0.	0.	8.2878	0.	58.4194	543.2252
C2		0.	0.	0.	8.5820	0.	58.5235	329.1333
C3O2		0.	0.	0.	23.3060	0.	85.0607	201.7332
C3		0.	0.	0.	12.8620	0.	62.8393	410.3678
C4N2		0.	0.	0.	28.6170	0.	99.2154	418.8083
C4		0.	0.	0.	18.3260	0.	77.0497	545.5092
C5		0.	0.	0.	23.5110	0.	83.8616	634.1504
NO+		0.	0.	0.	8.1248	0.	59.3739	123.2987
NO		0.493715E-14	0.18736515E-15	0.49371462E-14	8.1230	0.362406E 05	59.3767	-28.4709
NO2		0.	0.	0.	12.5270	0.	70.2775	-48.4418
N+		0.	0.	0.	4.9681	0.	42.6265	350.8301
N2O		0.	0.	0.	13.1080	0.	66.1341	-32.6595
N2O3		0.	0.	0.	23.3690	0.	98.3740	-53.6141
N2O4		0.	0.	0.	28.4820	0.	101.4507	-61.4816
N2O5		0.	0.	0.	33.7540	0.	109.3157	-71.7771
N2+		0.	0.	0.	7.8143	0.	54.4958	252.7238
N2		0.666709E 00	0.25301651E-01	0.66670856E 00	7.8150	0.489390E 19	54.5078	-45.6009
O-		0.	0.	0.	4.9990	0.	44.6186	47.5197
O+		0.	0.	0.	4.9990	0.	44.6186	272.6577
O2-		0.	0.	0.	8.3360	0.	58.1988	9.2895
O2+		0.	0.	0.	8.3360	0.	58.1988	261.1575
O2		0.	0.	0.	8.3360	0.	58.1918	-48.6535
O3		0.	0.	0.	13.0408	0.	70.9123	-22.4629
C	SOLID	0.	0.	0.	5.1490	0.	5.8441	89.1935
4	+01 1	+01 5	+01 0	+00				

APPENDIX H

Program Listing

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C       CHAIN(1,83)                                                     01H0001
C        ************** UPDATED 2/14/63                                 01H0002
C           SUBROUTINES REQUIRED IN CHAIN(1,  )                         01H0003
C                  INPUT 1                                              01H0004
C                  INPUT 2                                              01H0005
C                  DUMP2                                                01H0006
C                  SIFTIT                                               01H0007
C                  PERIOD                                               01H0008
C                  SELECT                                               01H0009
C                  SHIFT                                                01H0010
C                  INVRS                                                01H0011
C                  ESCORT                                               01H0012
C                  CHANGE                                               01H0013
C                  AEROSP                                               01H0014
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H0015
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H0016
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),   01H0017
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H0018
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H0019
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H0020
C       11 / 15/ 61                                                     01H0021
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H0022
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H0023
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H0024
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H0025
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H0026
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H0027
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H0028
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY               01H0029
      IF(NF)2,2,16                                                      01H0030
C*******************************************************************01H0031
 2    READ INPUT TAPE 2,4,ITA,ITB,ITC,ITD,ITE,ITF,ITG,ITH,              01H0032
C         ALTER THIS CARD FOR ANOTHER INPUT TAPE LOGICAL NUMBER         01H0033
C*******************************************************************01H0034
     *ITI,ITO,IP,IQ,IR,IS,IT,IU,IV,IW,IX,IY,NI                          01H0035
      CALL AEROSP(ITO)                                                  01H0036
      NF=0                                                              01H0037
 4    FORMAT(2113)                                                      01H0038
C     CARD ONE HAS ALL CONTROL CONSTANTS*****************************01H0039
      CALL LOOKA(2,1,ITI,ITO)                                           01H0040
C       LOOKA(N1,N2, INPUT TAPE,OUTPUT TAPE)                           01H0041
```

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C              LOCKA READS N1 CARDS IN ALPHABETIC FORMAT AND IMMEDIATELY01H0042
C              PRINTS THEM OUT IN THE SAME FORMAT. IF N2 IS ZERO,IT     01H0043
C              DOESNT START AT THE TOP OF THE NEXT PAGE                 01H0044
 6    READ INPUT TAPE ITI,8,TITLE,LANK                                  01H0045
      IG=0                                                              
 8    FORMAT(12A6/7A6)                                                  01H0046
      REWIND ITB                                                        01H0047
      REWIND ITC                                                        01H0048
      REWIND ITD                                                        01H0049
      REWIND ITE                                                        01H0050
      CALL SETH(ITB)                                                    01H0051
      CALL SETH(ITC)                                                    01H0052
      CALL SETH(ITD)                                                    01H0053
      CALL SETH(ITE)                                                    01H0054
      CALL LOCKA(2,0,ITI,ITO)                                           01H0055
      READ INPUT TAPE ITI,10,IH,IJ,IK,IL                               01H0056
C              IH CONTROLS THE TYPE OF INGREDIENT PROPORTION            01H0057
C              IJ SPECIFIES THE SOLUTION TYPE                           01H0058
C              IK IS THE NUMBER OF INGREDIENTS                          01H0059
C              IL IS THE NUMBER OF COMBINATIONS REQUIRED                01H0060
 10   FORMAT(4I12)                                                      01H0061
      IF(IH-6)12,46,46                                                  01H0062
 12   READ INPUT TAPE ITI,14,PREF,(ABLOCK(I),I=2,6)                    01H0063
C16   BOX-A-*************************************************************01H0064
 14   FORMAT(6F12.8)                                                    01H0065
 16   IF(NF-IL)18,2,2                                                   01H0066
C18   NF=NO OF COMPLETED POINTS,IL=NO OF POINTS REQUIRED                01H0067
C     IN THIS SET*******************************************************01H0068
 18   GO TO(20,22,24,26,28),IH                                          01H0069
 20   CALL INPUT1(L)                                                    01H0070
      GO TO(29,54),L                                                    01H0071
 22   CALL INPUT1(L)                                                    01H0072
      GO TO(29,54),L                                                    01H0073
 24   CALL INPUT1(L)                                                    01H0074
      GO TO(29,56),L                                                    01H0075
 26   CALL INPUT2(L)                                                    01H0076
      GO TO(29,58),L                                                    01H0077
 28   CALL INPUT2(L)                                                    01H0078
      GO TO(29,58),L                                                    01H0079
 29   IF(IJ-7)30,48,48                                                  01H0080
 30   GO TO(32,34,36,38,40,42,44),IJ                                    01H0081
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 32   CALL CHAIN(2,ITA)                                                  01H0082
C     **************ROCKET PERFORMANCE**************************************01H0083
 34   CALL CHAIN(5,ITA)                                                  01H0084
C     **************MOLLIER DIAGRAM****************************************01H0085
 36   CALL CHAIN(8,ITA)                                                  01H0086
C     **************SIMPLE EQUILIBRIUM-SOLID OR GAS************************01H0087
 38   CALL CHAIN(11,ITA)                                                 01H0088
C    SHOCK PERFORMANCE   ***************************************************01H0089
 40   CALL CHAIN(14,ITA)                                                 01H0090
C     NOT SPECIFIED                                                      01H0091
 42   CALL CHAIN(17,ITA)                                                 01H0092
C     NOT SPECIFIED                                                      01H0093
 44   CALL CHAIN(20,ITA)                                                 01H0094
C46   ERROR 1 IH OVER 5***************************************************01H0095
 46   N=1                                                                01H0096
      GO TO 60                                                           01H0097
C48   IJ OVER 6***********************************************************01H0098
 48   N=2                                                                01H0099
      GO TO 60                                                           01H0100
C54   ERROR IN MOLES OR MOLE PERCENT**************************************01H0101
 54   N=3                                                                01H0102
      GO TO 60                                                           01H0103
C56   ERROR IN WEIGHT PERCENT*********************************************01H0104
 56   N=4                                                                01H0105
      GO TO 60                                                           01H0106
C58   ERROR IN M/R OR O/R**************************************************01H0107
 58   N=5                                                                01H0108
 60   WRITE OUTPUT TAPE ITO,62,N                                         01H0109
 62   FORMAT(27H  ERROR IN CHAIN 1 OF TYPE I12/                          01H0110
     *20H      PROBLEM DELETED)                                         01H0111
      GO TO 2                                                            01H0112
      END                                                                01H0113
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C     CHAIN (2,3)   ROCKET PERFORMANCE MAIN CALCULATION PROGRAM          01H0133
C        ************** UPDATED 2/14/63                                  01H0134
C           SUBROUTINES REQUIRED IN CHAIN(2,  )                         01H0135
C                 GETMAJ                                                01HC_36
C                 BUILD                                                 01H0137
C                 CHECK                                                 01H0138
C                 CROUT                                                 01H0139
C                 GENPIS                                                01H0140
C                 LOGS                                                  01H0141
C                 SOLIDS                                                01H0142
C                 JUGGLE                                                01H0143
C                 GETDJS                                                01H0144
C                 GETYJS                                                01H0145
C                 SIFTIT                                                01H0146
C                 DUMP2                                                 01H0147
C                 ESCORT                                                01H0148
C                 LINCH                                                 01H0149
C                 INTERP                                                01H0150
C                 PTABL                                                 01H0151
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H0152
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H0153
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H0154
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H0155
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H0156
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H0157
      DIMENSION DJ(150), YJ(150), XIP(150)                             01H0158
C     1/19/62                                                          01H0159
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H0160
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H0161
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H0162
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H0163
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H0164
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H0165
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H0166
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY               01H0167
     *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                       01H0168
      IT=IT                                                            01H0169
      NF=NF                                                            01H0170
      L=L                                                              01H0171
      ICOMB=0                                                          01H0172
      ITHROT=0                                                         01H0173
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      IEXPAN=0                                                          01H0174
      REWIND ITB                                                        01H0175
      MM=NA*10                                                          01H0176
      MM=XMAXOF(50,MM)                                                  01H0177
      IF(IT) 2,4,4                                                      01H0178
 2    MM=2*MM                                                           01H0179
      IT=0                                                              01H0180
 4    MM=MM-10                                                          01H0181
      REWIND ITG                                                        01H0182
      IF(NF)12,12,10                                                    01H0183
 10   READ  TAPE ITG,TEMP,PREF,NA,BIGA,((BIBLE(I,J),I=1,NA),J=1,NA),NB, 01H0184
     *(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITATE(I),I=1,ND),(PARRAY(I), 01H0185
     *IMAJOR(I),I=1,NA)                                                 01H0186
      REWIND ITG                                                        01H0187
      CALL LOGS                                                         01H0188
      TT=TEMP                                                           01H0189
      CALL INTERP(TT,NONE,DELTA)                                        01H0190
      IF(NONE) 11, 18, 11                                               01H0191
 11   TEMP=ABLOCK(3)                                                    01H0192
      CALL LOGS                                                         01H0193
      GO TO 18                                                          01H0194
C12   NEW PROBLEM-NO CHAMBER DATA ON ITC ********************************01H0195
 12   IZ=4                                                              01H0196
      MM=0                                                              01H0197
      IM=0                                                              01H0198
      NB=0                                                              01H0199
      IF(ABLOCK(3))14,14,16                                             01H0200
 14   ABLOCK(3)=3000.                                                   01H0201
 16   TEMP=ABLOCK(3)                                                    01H0202
      ABLOCK(1)=PREF                                                    01H0203
      PREF=PREF/14.696006                                               01H0204
      BIGA=20.*PREF                                                     01H0205
 18   LE=0                                                              01H0206
C     LOOP ONE COUNTER SET                                              01H0207
C     SETUP FOR CONSTANT TEMP COMBUSTION MATRIX *************************01H0208
      KA=0                                                              01H0209
      KB=1                                                              01H0210
      KC=0                                                              01H0211
      KT=1                                                              01H0212
 100  CALL GETMAJ(L)                                                    01H0213
      CALL BUILD(L)                                                     01H0214
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      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                 01H0215
      CALL CHECK(L)                                                     01H0216
      ICOMB=ICOMB+1                                                     01H0217
      LE=LE+1                                                           01H0218
      IF(LE-MN)102,104,104                                              01H0219
  102 IF(IT)108,108,104                                                 01H0220
  104 CALL DUMP2(100.)                                                  01H0221
      IF(LE-MM)108,108,106                                              01H0222
  106 CALL ESCORT(100.)                                                 01H0223
  108 GO TO (100,110),L                                                 01H0224
C110  CORRECT LOOP EXIT-CHAMBER DONE ***********************************01H0225
  110 WRITE TAPE ITG,TEMP,PREF,NA,BIGA,((BIBLE(I,J),I=1,NA),J=1,NA),NB, 01H0226
     *(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITATE(I),I=1,ND),(PARRAY(I), 01H0227
     *IMAJOR(I),I=1,NA)                                                 01H0228
  112 REWIND ITG                                                        01H0229
      KA=1                                                              01H0230
      CALL BUILD(L)                                                     01H0231
      N=NC-1                                                            01H0232
      SC=-A(NC,N)/BIGA                                                  01H0233
C     VELOCITY OF SOUND MATRIX **************************************01H0234
      LF=0                                                              01H0235
  200 KA=1                                                              01H0236
      KB=0                                                              01H0237
      KC=0                                                              01H0238
      KT=-1                                                             01H0239
      CALL GETMAJ(L)                                                    01H0240
  202 CALL BUILD(L)                                                     01H0241
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                 01H0242
      IF(IU) 201, 203, 201                                              01H0243
  201 CALL DUMP2(199.)                                                  01H0244
  203 CALL GETDJS(DJ,DAM1)                                              01H0245
C     MACH ONE MATRIX ***********************************************01H0246
      KC=1                                                              01H0247
  205 CALL BUILD(L)                                                     01H0248
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                 01H0249
      CALL CHECK(L)                                                     01H0250
      ITHROT=ITHROT+1                                                   01H0251
      LF=LF+1                                                           01H0252
      IF(LF-MN)204,206,206                                              01H0253
  204 IF(IU)209,209,206                                                 01H0254
  206 CALL DUMP2(200.)                                                  01H0255
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      IF(LF-MM)209,209,208                                                  01H0256
  208 CALL ESCORT(200,)                                                     01H0257
  209 IF(KT) 210, 210, 205                                                  01H0258
  210 GO TO(200,212),L                                                      01H0259
C212  THROAT COMPLETED ***************************************************01H0260
  212 PTHR=0.                                                               01H0261
      GAMTH=0.                                                              01H0262
      DO 214 I=1,NG                                                         01H0263
      GAMTH=GAMTH+PRESS(I)*DJ(I)                                            01H0264
  214 PTHR=PTHR+PRESS(I)                                                    01H0265
      GAMTH=GAMTH/(DAM1*PTHR)                                               01H0266
      EMTH=BIGA/PTHR                                                        01H0267
      ATOWD=189.27599*TEMP/(PTHR*EMTH*299.15427*SQRTF(                      01H0268
     *GAMTH*TEMP/EMTH))                                                     01H0269
      CSTAR=472.829104*PREF*ATOWD                                           01H0270
      ABLOCK(5)=CSTAR                                                       01H0271
      ABLOCK(7)=PTHR                                                        01H0272
      CALL PTABL(0,PTHR,PREF)                                               01H0273
C     OBTAINS REFERENCE EXPANSION PRESSURE RATIO TO PTHROAT                 01H0274
      PC=ABLOCK(1)/14.696006                                                01H0275
C     START OUTPUT EXPANSION LOOP SET ***********************************01H0276
      PC=PREF                                                               01H0277
      READ  TAPE ITG,TEMP,PREF,NA,BIGA,((BIBLE(I,J),I=1,NA),J=1,NA),NB,     01H0278
     *(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITATE(I),I=1,ND),(PARRAY(I),     01H0279
     *IMAJOR(I),I=1,NA)                                                     01H0280
      REWIND ITG                                                            01H0281
      CALL LOGS                                                             01H0282
      REWIND ITB                                                            01H0283
      NONE=0                                                                01H0284
      NSUB=0                                                                01H0285
      IF(IS) 218, 218, 216                                                  01H0286
  216 IF(IS-24) 217,218,218                                                 01H0287
  217 NEND=24-IS                                                            01H0288
      GO TO 220                                                             01H0289
  218 NEND=24                                                               01H0290
  220 DO 340 NDO=1,NEND                                                     01H0291
      LG=0                                                                  01H0292
      CALL PTABL(NDO,P1,PC)                                                 01H0293
      PREF=PC/P1                                                            01H0294
      KA=1                                                                  01H0295
      KB=1                                                                  01H0296
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      KC=0                                                                  01H0297
      KT=0                                                                  01H0298
  300 CALL GETMAJ(L)                                                        01H0299
      CALL BUILD(L)                                                         01H0300
      N=NC-1                                                                01H0301
      SI=-A(NC,N)/BIGA                                                      01H0302
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                     01H0303
      CALL CHECK(L)                                                         01H0304
      IEXPAN=IEXPAN+1                                                       01H0305
      LG=LG+1                                                               01H0306
      IF(LG-MN)302,302,304                                                  01H0307
  302 IF(IV)307,307,304                                                     01H0308
  304 CALL DUMP2(300.)                                                      01H0309
      IF(LG-MM)307,307,306                                                  01H0310
  306 CALL ESCORT(300.)                                                     01H0311
      NSUB=NSUB+1                                                           01H0312
      GO TO 340                                                             01H0313
  307 GO TO(300,308),L                                                      01H0314
C308  EXPANSION AT CONSTANT ENTROPY COMPLETED **************************01H0315
C     ACOUSTIC VELOCITY MATRIX ************************************************01H0316
  308 KA=1                                                                  01H0317
      KB=0                                                                  01H0318
      KC=0                                                                  01H0319
      KT=-1                                                                 01H0320
      CALL BUILD(L)                                                         01H0321
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                     01H0322
      CALL GETDJS(DJ,DAM1)                                                  01H0323
C     COEFFICIENT OF HEAT EXPANSION AT CONST PRESS ********************01H0324
      KA=-1                                                                 01H0325
      CALL BUILD(L)                                                         01H0326
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                     01H0327
      CALL GETYJS                                                           01H0328
      GAMEXP=0.                                                             01H0329
      CPEXP=0.                                                              01H0330
      DO 326 I=1,ND                                                         01H0331
      IF(MASKPR(I))326,320,326                                              01H0332
  320 IF(PRESS(I)-1.E-10)326,322,322                                        01H0333
  322 CPEXP=CPEXP+1000./TEMP*(PRESS(I)*CPHSDK(2,I)*YJ(I)-CPHSDK(2,I)*      01H0334
     *YJA*PRESS(I)+TEMP/1000.*PRESS(I)*CPHSDK(1,I))                         01H0335
      IF(I-NG)324,324,326                                                   01H0336
  324 GAMEXP=GAMEXP+PRESS(I)*DJ(I)                                          01H0337
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  326  CONTINUE                                                          01H0338
       GAMEXP=GAMEXP/(DAM1*PREF)                                         01H0339
       CPEXP=CPEXP/BIGA                                                  01H0340
       XGAS=0.                                                           01H0341
       DO 328 I=1,ND                                                     01H0342
  328  XIP(I)=100.*PRESS(I)/PREF                                         01H0343
       DO 330 I=1,NG                                                     01H0344
  330  XGAS=XGAS+XIP(I)                                                  01H0345
       CMEXP=PREF*XGAS/BIGA                                              01H0346
       P=14.696006*PREF                                                  01H0347
C      COMPUTE OUTPUT PARAMETERS ****************************************01H0348
       HE=0.                                                             01H0349
       SE=0.                                                             01H0350
       ZERO=0.                                                           01H0351
       CMEXT=BIGA/PREF                                                   01H0352
       DO 334 I=1,ND                                                     01H0353
       IF(MASKPR(I))334,332,334                                          01H0354
  332  HE=HE+PRESS(I)*CPHSDK(2,I)                                        01H0355
       SE=SE+PRESS(I)*CPHSDK(3,I)                                        01H0356
       IF(ITATE(I)-1) 334,333,334                                        01H0357
  333  SE=SE-1.98725*PRESS(I)*PLN(I)                                     01H0358
  334  CONTINUE                                                          01H0359
       HE=HE/BIGA                                                        01H0360
       SE=SE/BIGA                                                        01H0361
       HD=HE*1000.                                                       01H0362
       DO 337 I=1,ND                                                     01H0363
  337  XIP(I)=PRESS(I)/BIGA*100.                                         01H0364
       WRITE TAPE ITB,P,TEMP,HD,SI,CPEXP,GAMEXP,CMEXT,ZERO,ZERO,         01H0365
      *(XIP(I),I=1,ND)                                                   01H0366
       IF(NDO-1) 336,336,338                                             01H0367
  336  WRITE TAPE ITB,P1,P,TEMP,HD,GAMEXP,ZERO,ZERO,ZERO                 01H0368
       GO TO 340                                                         01H0369
  338  EI=294.98*SQRTF(HC-HE)                                            01H0370
       AEOWD=5.882893*TEMP/(PREF*CMEXT*EI)                               01H0371
       EPSIL=AEOWD/ATOWD                                                 01H0372
       CF=32.174*EI/CSTAR                                                01H0373
       WRITE TAPE ITB,P1,P,TEMP,HD,GAMEXP,EPSIL,CF,EI                    01H0374
       NM=NDONE+1                                                        01H0375
  340  NDONE=NDONE+1                                                     01H0376
       NM=NDONE-NSUB                                                     01H0377
  400  REWIND ITB                                                        01H0378
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      WRITE OUTPUT TAPE ITO,406, ICOMB,ITHROT,IEXPAN                    01H0379
406   FORMAT('06X,I4,I3,I5)                                             01H0380
      IF(IS) 402, 404, 402                                              01H0381
402     CALL CHAIN(4,ITA)                                               01H0382
404   CALL CHAIN(3,ITA)                                                 01H0383
      END
```

```
C            CHAIN(3,   )      ROCKET PERFORMANCE OUTPUT                    01H0385
C         ************** UPDATED 2/14/63                                     01H0386
C            SUBROUTINES REQUIRED IN CHAIN(3,  )                            01H0387
C                  PARB                                                     01H0388
C                  CHANGE                                                   01H0389
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(      01H0390
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(       01H0391
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),       01H0392
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H0393
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H0394
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)            01H0395
      DIMENSION DJ(150),YJ(150)                                          01H0396
C     1/19/62                                                            01H0397
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H0398
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H0399
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H0400
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    01H0401
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H0402
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H0403
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H0404
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                 01H0405
     *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                         01H0406
      DIMENSION TABL1(24,159),TABL2(24,8),PCPE(50),EPS(50),              01H0407
     *PULSE(50),EPS1(50),CFO(50),FOPT(50),AB(2,50),FEP(50),             01H0408
     *CFE(50),PCP(50)                                                   01H0409
      CALL CHANGE(IONE,6HONE    )                                        01H0410
      CALL CHANGE(ITWO,6HTWO    )                                        01H0411
      CALL CHANGE(ITHREE,6HTHREE )                                       01H0412
      REWIND ITA                                                         01H0413
      REWIND ITB                                                         01H0414
      IPSAVE=IP                                                          01H0415
      ILSAVE=IL                                                          01H0416
      NTBL=ND+9                                                          01H0417
      II=1                                                               01H0418
      CSTAR=ABLOCK(5)                                                    01H0419
      ICSTAR=CSTAR                                                       01H0420
      I2=1                                                               01H0421
      I3=8                                                               01H0422
      IF(NH-8)2,2,1                                                      01H0423
    2 II=2                                                               01H0424
      GO TO 4                                                            01H0425
```

```
1     NEXITP=XMINOF(NH,24)                                                    01H0426
4     DO 3 I=1,NEXITP                                                         01H0427
      READ TAPE ITB,(TABL1(I,J),J=1,NTBL)                                     01H0428
3     READ TAPE ITB,(TABL2(I,J),J=1,8)                                        01H0429
      DO 108 I=1,NEXITP                                                       01H0430
      SUMGAS=0.                                                               01H0431
      SUMSOL=0.                                                               01H0432
      DO 106 J=1,ND                                                           01H0433
      IF(MASKPR(J)) 106,100, 106                                              01H0434
100   IF(ITATE(J)-1) 106, 103,104                                             01H0435
103   SUMGAS=SUMGAS+TABL1(I,J+9)                                              01H0436
      GO TO 106                                                               01H0437
104   SUMSOL=SUMSOL+TABL1(I,J+9)                                              01H0438
106   CONTINUE                                                                01H0439
      TABL1(I,8)=SUMGAS                                                       01H0440
108   TABL1(I,9)=SUMSOL                                                       01H0441
      IPC=ABLOCK(1)                                                           01H0442
      IF(II-2)20,6,20                                                         01H0443
6     WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I)                   01H0444
     *,I=1,18),IPC,IONE                                                       01H0445
      WRITE OUTPUT TAPE ITO,509,(TABL1(I,1),I=1,NEXITP)                       01H0446
      WRITE OUTPUT TAPE ITO,510,(TABL1(I,2),I=1,NEXITP)                       01H0447
      WRITE OUTPUT TAPE ITO,511,(TABL1(I,3),I=1,NEXITP)                       01H0448
      WRITE OUTPUT TAPE ITO,512,(TABL1(I,4),I=1,NEXITP)                       01H0449
      WRITE OUTPUT TAPE ITO,513,(TABL1(I,5),I=1,NEXITP)                       01H0450
      WRITE OUTPUT TAPE ITO,514,(TABL1(I,6),I=1,NEXITP)                       01H0451
      WRITE OUTPUT TAPE ITO,515,(TABL1(I,7),I=1,NEXITP)                       01H0452
      WRITE OUTPUT TAPE ITO,516,(TABL1(I,8),I=1,NEXITP)                       01H0453
      WRITE OUTPUT TAPE ITO,517,(TABL1(I,9),I=1,NEXITP)                       01H0454
      WRITE OUTPUT TAPE ITO,518                                               01H0455
      IJUMP=0                                                                 01H0456
      DO 16 J=1,ND                                                            01H0457
      J2=J+9                                                                  01H0458
      IP=0                                                                    01H0459
      DO 10 I=1,NEXITP                                                        01H0460
      IF(TABL1(I)-1.E-5)8,10,10                                               01H0461
8     IP=IP+1                                                                 01H0462
10    CONTINUE                                                                01H0463
      IF(MASKPR(J))16,12,16                                                   01H0464
12    IF(IP-NEXITP) 14,16,16                                                  01H0465
14    WRITE OUTPUT TAPE ITO,519,(NAME(K,J),K=1,2),(TABL1(I,J2),               01H0466
```

```
     *I=1,NEXITP)                                                          01H0467
16    CONTINUE                                                             01H0468
      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),               01H0469
     *I=1,18),IPC,ITWO                                                     01H0470
      WRITE OUTPUT TAPE ITO,520,ICSTAR,((TABL2(I,J),J=1,8),I               01H0471
     *=1,NEXITP)                                                           01H0472
18    GO TO 58                                                             01H0473
20    K=-7                                                                 01H0474
22    M=XMINOF(I3,NEXITP)                                                  01H0475
      K=K+8                                                                01H0476
      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),               01H0477
     *I=1,18),IPC,IONE                                                     01H0478
      WRITE OUTPUT TAPE ITO,509,(TABL1(I,1),I=K,M)                         01H0479
      WRITE OUTPUT TAPE ITO,510,(TABL1(I,2),I=K,M)                         01H0480
      WRITE OUTPUT TAPE ITO,511,(TABL1(I,3),I=K,M)                         01H0481
      WRITE OUTPUT TAPE ITO,512,(TABL1(I,4),I=K,M)                         01H0482
      WRITE OUTPUT TAPE ITO,513,(TABL1(I,5),I=K,M)                         01H0483
      WRITE OUTPUT TAPE ITO,514,(TABL1(I,6),I=K,M)                         01H0484
      WRITE OUTPUT TAPE ITO,515,(TABL1(I,7),I=K,M)                         01H0485
      WRITE OUTPUT TAPE ITO,516,(TABL1(I,8),I=K,M)                         01H0486
      WRITE OUTPUT TAPE ITO,517,(TABL1(I,9),I=K,M)                         01H0487
      WRITE OUTPUT TAPE ITO,518                                            01H0488
      DO 30 J=1,ND                                                         01H0489
      IP=0                                                                 01H0490
      J3=J+9                                                               01H0491
      DO 26 I=K,M                                                          01H0492
      IF(TABL1(I,J3)-1.E-5)24,26,26                                        01H0493
24    IP=IP+1                                                              01H0494
26    CONTINUE                                                             01H0495
      MX=M-K+1                                                             01H0496
      IF(IP-MX)28,30,30                                                    01H0497
28    WRITE OUTPUT TAPE ITO,519,(NAME(I,J),I=1,2),(TABL1(I,                01H0498
     *J3),I=K,M)                                                           01H0499
30    CONTINUE                                                             01H0500
      IF(NEXITP-I3)36,36,32                                                01H0501
32    IF(M-I3)36,34,36                                                     01H0502
34    I3=I3+8                                                              01H0503
      GO TO 22                                                             01H0504
36    WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),I              01H0505
     *=1,18),IPC,ITWO                                                      01H0506
      WRITE OUTPUT TAPE ITO,520,ICSTAR,((TABL2(I,J),J=1,8),I=              01H0507
```

```
     *1,NEXITP)                                                          01H0508
      NQ=NEXITP-4                                                        01H0509
      DO 38 I=1,NQ                                                       01H0510
      KK=I+4                                                             01H0511
      PCPE(I)=TABL2(KK,1)                                                01H0512
      EPS(I)=TABL2(KK,6)                                                 01H0513
38    PULSE(I)=TABL2(KK,8)                                               01H0514
      ARG=0.                                                             01H0515
      IF(EPS(NQ)-3.) 58,58,40                                            01H0516
40    M=MINIF(EPS(NQ),50.)                                               01H0517
      DO 42 I=1,M                                                        01H0518
      ARG=ARG+1.                                                         01H0519
      PCP(I)=PARB(EPS,PCPE,ARG,NQ)                                       01H0520
      FOPT(I)=PARB(EPS,PULSE,ARG,NQ)                                     01H0521
      TTT=CSTAR*ARG/32.174                                               01H0522
      AB(1,I)=TTT/PCP(I)                                                 01H0523
      AB(2,I)=TTT/TABL2(1,2)                                             01H0524
      FEP(I)=FOPT(I)+AB(1,I)                                             01H0525
      CFE(I)=32.174*FEP(I)/CSTAR                                         01H0526
      CFO(I)=FOPT(I)*32.174/CSTAR                                        01H0527
42    EPS1(I)=ARG                                                        01H0528
      MM=0                                                               01H0529
      KK=1                                                               01H0530
44    MM=MM+25                                                           01H0531
      MM=XMINOF(MM,M)                                                    01H0532
48    WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),I            01H0533
     *=1,18),IPC,ITHREE                                                  01H0534
54    WRITE OUTPUT TAPE ITO,522,(EPS1(I),PCP(I),FOPT(I),AB(1,            01H0535
     *I),AB(2,I),FEP(I),CFO(I),CFE(I),I=KK,MM)                           01H0536
      KK=MM+1                                                            01H0537
      IF(MM-M) 44, 58, 58                                                01H0538
58    REWIND ITS                                                         01H0539
      NF=NF+1                                                            01H0540
      IP=IPSAVE                                                          01H0541
      IL=ILSAVE                                                          01H0542
59    CALL CHAIN(1,ITA)                                                  01H0543
500   FORMAT(1H1,2X,26(1H*),51H SHIFTING EQUILIBRIUM EXPANSION-ROCKET PE01H0544
     *RFORMANCE ,26(1H*)//1X,25HTHERMO DATA LIBRARY TAPE ,2A6//2X,18A6//01H0545
     *37X,18HCHAMBER PRESSURE =,I10,5H PSIA//48X,6HTABLE ,1A6)           01H0546
510   FORMAT(6X,19HTEMPERATURE (DEG K),8F10.3)                           01H0547
511   FORMAT(6X,11HH   (CAL/GM),8X,8F10.1)                               01H0548
```

```
  512  FORMAT(6X,17HS  (CAL/GM-DEG K),2X,8F10.3)                          01H0549
  513  FORMAT(6X,11HCP (CAL/GM),8X,8F10.3)                                01H0550
  514  FORMAT(6X, 5HGAMMA,14X,8F10.3)                                     01H0551
  515  FORMAT(6X,19HAVERAGE GAS MOLE WT,8F10.3)                           01H0552
  516  FORMAT(6X,17HGAS MOLES/100 GM ,F12.5,7F10.5)                       01H0553
  517  FORMAT(6X,18HCOND MOLES/100 GM ,F11.5,7F10.5//)                    01H0554
  518  FORMAT(1X,42HCOMPOSITION-MOLES PER 100 GRAMS PROPELLANT//)         01H0555
  519  FORMAT(6X,2A6,7X,8F10.5)                                           01H0556
  509  FORMAT(2X,49HTHERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE//6X01H0557
      *15HPRESSURE (PSIA),4X,8F10.3)                                     01H0558
  520  FORMAT(44X,6HC*    =I6,7H FT/SEC//10X,5HPC/PE,8X,1HP,13X,1HT,13X,1H01H0559
      *H,8X,5HGAMMA,6X,7HEPSILON,8X,2HCF,9X,2HIS/22X,4HPSIA,9X,6HDEG.-K,801H0560
      *X,6HCAL/GM,39X,9HLB-SEC/LB//(8(F15.4,F13.4,F13.1,F15.2,F11.4,F12.401H0561
      *,F11.4,F12.2/)))                                                  01H0562
  522  FORMAT(/8X,7HEPSILON,8X,5HPC/PE,9X,5HI OPT,10X,1HA,12X,1HB,10X,5HI01H0563
      * EPS,5X,6HCF OPT,5X,6HCF EPS//(5(F15.4,F14.4,F13.2,F14.2,F13.2,  01H0564
      *F12.2,2F11.4/)))                                                  01H0565
       END                                                               01H0566
```

```
C      GENERAL PURPOSE SOLVER                                                  06H0001
       DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(        06H0002
      * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(         06H0003
      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),        06H0004
      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK06H0005
      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),06H0006
      * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)                 06H0007
       DIMENSION DJ(150),YJ(150)                                               06H0008
C      1/19/62                                                                 06H0009
       DIMENSION F(150),XIP(150)                                               06H0010
       COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU06H0011
      *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 06H0012
      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,06H0013
      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    06H0014
      * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  06H0015
      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 06H0016
      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY06H0017
      * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                      06H0018
      *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                              06H0019
C      DATA CARD 5 SPECIAL STRUCTURE                                           06H0020
C          CARD FORMAT -6F12.8                                                 06H0021
C          LAST NUMBER ON CARD (60-72)                                         06H0022
C              IF =1    MOLLIER SOLUTION                                       06H0023
C              IF =2    EQUILIBRIUM OVER A FIXED PRESSURE-VARIABLE TEMP        06H0024
C              IF =3    POINT SOLUTION REQUIRED AT GIVEN TEMP AND PRESS        06H0025
C      ********** CONTROL OF 1                                                 06H0026
C                *   ABLOCK(1)=UPPER PRESSURE                                  06H0027
C                *   ABLOCK(2)=LOWER PRESSURE                                  06H0028
C                *   ABLOCK(3)=UPPER TEMPERATURE                               06H0029
C                *   ABLOCK(4)=LOWER TEMPERATURE                               06H0030
C                *   ABLOCK(5)=TEMPERATURE INCREMENT (DECREMENT)               06I 0031
C      ********** CONTROL OF 2                                                 06H0032
C                *   ABLOCK(1)=PRESSURE                                        06H0033
C                *   ABLOCK(2)=NOT USED                                        06H0034
C                *   ABLOCK(3)=UPPER TEMPERATURE                               06H0035
C                *   ABLOCK(4)=LOWER TEMPERATURE                               06H0036
C                *   ABLOCK(5)=TEMPERATURE INCREMENT (DECREMENT)               06H0037
C      ********** CONTROL OF 3                                                 06H0038
C                *   ABLOCK(1)=PRESSURE                                        06H0039
C                *   ABLOCK(2)=NOT USED                                        06H0040
C                *   ABLOCK(3)=NOT USED                                        06H0041
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C              *   ABLOCK(4)=NOT USED                                          06H0042
C              *   ABLOCK(5)=NOT USED                                          06H0043
C              *   ABLOCK(6)=CONTROL INDICATOR AS STATED ABOVE                 06H0044
C     ***************************************************************************06H0045
      REWIND ITA                                                                06H0046
      IZ=4                                                                      06H0047
      NB=0                                                                      06H0048
      IE=1                                                                      06H0049
      IM=0                                                                      06H0050
      ITA=ITA                                                                   06H0051
      ITC=ITC                                                                   06H0052
      ITD=ITD                                                                   06H0053
      INT=0                                                                     06H0054
      MM=50                                                                     06H0055
      IF( NF )   4, 4 , 6                                                       06H0056
 4    ABLOCK(1)=PREF/14.696                                                     06H0061
      IF(IT) 3,6,6                                                              06H0062
 3    MM=100                                                                    06H0063
      IT=0                                                                      06H0064
 6    PREF=ABLOCK(1)                                                            06H0065
      IF(ABLOCK(6)-2.)   2,24,42                                                06H0066
 2    ILOOP=1                                                                   06H0067
      IF(ABLOCK(2))   8, 8,10                                                   06H0068
 8    ABLOCK(2)=1.E-03                                                          06H0069
 10   PFINAL=ABLOCK(2)/14.696006                                                06H0070
      IF(ABLOCK(3))  12,12,14                                                   06H0071
 12   ABLOCK(3)=6000.                                                           06H0072
 14   TEMP=ABLOCK(3)                                                            06H0073
      IF(ABLOCK(4)) 16,16,18                                                    06H0074
 16   ABLOCK(4)=298.158                                                         06H0075
 18   TFINAL=ABLOCK(4)                                                          06H0076
      IF(ABLOCK(5)) 20,20,22                                                    06H0077
 20   ABLOCK(5)=100.                                                            06H0078
 22   TDECR=ABLOCK(5)                                                           06H0079
      GO TO 52                                                                  06H0080
 24   ILOOP=2                                                                   06H0081
      PFINAL=PREF                                                               06H0082
      IF(ABLOCK(3)) 30, 30,  32                                                 06H0083
 30   ABLOCK(3)=6000.                                                           06H0084
 32   TEMP=ABLOCK(3)                                                            06H0085
      IF(ABLOCK(4)) 34,34,36                                                    06H0086
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```
 34   ABLOCK(4)=298.158                                                    06M0087
 36   TFINAL=ABLOCK(4)                                                     06M0088
      IF(ABLOCK(5)) 38,38,40                                               06M0089
 38   ABLOCK(5)=100.                                                       06M0090
 40   TDECR=ABLOCK(5)                                                      06M0091
      GO TO 52                                                             06M0092
 42   ILOOP=3                                                              06M0093
      TDECR=100.                                                           06M0094
      IF(ABLOCK(3)) 48,48,50                                               06M0095
 48   ABLOCK(3)=6000.                                                      06M0096
 50   TEMP=ABLOCK(3)                                                       06M0097
C52   START SYSTEM COMPUTATION.                                            06M0098
 52   GO TO(54,58,62),ILOOP                                                06M0099
 54   WRITE OUTPUT TAPE ITO,56,HC                                          06M0100
 56   FORMAT(70H   MOLLIER DIAGRAM OPTION SELECTED,UNHEATED SYSTEM ENTHA06M0101
     *LPY (KCAL/GM)= F11.5)                                               06M0102
      IY=1                                                                 06M0103
      GO TO 66                                                             06M0104
 58   WRITE OUTPUT TAPE ITO,60,HC                                          06M0105
 60   FORMAT(70H   EQUILIBRIUM GAS OPTION SELECTED,UNHEATED SYSTEM ENTHA06M0106
     *LPY (KCAL/GM)= F11.5)                                               06M0107
      IY=1                                                                 06M0108
      GO TO 66                                                             06M0109
 62   WRITE OUTPUT TAPE ITO,64,HC                                          06M0110
 64   FORMAT(72H   FLAME COMPOSITION OPTION SELECTED,UNHEATED SYSTEM ENT06M0111
     *HALPY (KCAL/GM)= F11.5)                                             06M0112
      IY=0                                                                 06M0113
 66   KA=0                                                                 06M0114
      KB=1                                                                 06M0115
      KC=0                                                                 06M0116
      KT=1                                                                 06M0117
      IM=0                                                                 06M01172
      NB=0                                                                 06M01174
      IPREF=0                                                              06M0118
      ITEMP=0                                                              06M0119
      BIGA=25.*PREF                                                        06M0120
      IONG=0                                                               06M0121
      IRETRY=0                                                             06M0122
      TRESET=TEMP                                                          06M0123
      IDONE=0                                                              06M0124
 68   LE=0                                                                 06M0125
```

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      POLD=PREF                                                          06H0126
      CALL LOGS                                                          06H0127
      CALL GENPIS                                                        06H0128
 70   CALL GETMAJ(L)                                                     06H0129
      CALL BUILD(L)                                                      06H0130
      CALL CROUT(A,ANS,NC,DETERM,NOERR)                                  06H0131
      CALL CHECK(L)                                                      06H0132
      LE=LE+1                                                            06H0133
      IF(IT) 700,702,700                                                 06H0134
 700  CALL DUMP2(1.)                                                     06H0135
 702  IF(KE-1) 73, 73, 72                                                06H0136
 72   PREF=0.                                                            06H0137
      DO 2224 I=1,NG                                                     06H0138
 2224 PREF=PREF+PRESS(I)                                                 06H0139
      BIGA=BIGA*PREF/POLD                                                06H0140
      GO TO 2442                                                         06H0141
 73   IF(LE-MM) 74, 200 ,200                                             06H0142
 74   GO TO (70, 1200),L                                                 06H0143
 200  IF(IONG)212 , 212,202                                              06H0144
C   PROBLEM HAS TROUBLE IN CONVERGING AT THIS TEMPERATURE                06H0145
C        THE SYSTEM WILL BE RESET TO THE LAST COMPLETED POINT AND        06H0146
C        THE TEMPERATURE RESET TO A SMALLER DECREMENT                    06H0147
 202  IF(ITEMP)206, 204,206                                              06H0148
 204  ITEMP=1                                                            06H0149
      TRESET=TEMP                                                        06H0150
      TAGAIN=TEMP+TDECR                                                  06H0151
 206  TDECR=TDECR/2.                                                     06H0152
      TEMP=TAGAIN-TDECR                                                  06H0153
      BACKSPACE ITG                                                      06H0154
C    RESET SYSTEM TO LAST CONDITIONS WHICH CONVERGED                     06H0155
 207  READ TAPE  ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITA06H0156
     *TE(I),I=1,ND),((BIBLE(I,J),I=1,NA),J=1,NA),(IMAJOR(I),PARRAY(I),I=06H0157
     *1,NA)                                                              06H0158
      IRETRY=IRETRY+1                                                    06H0159
      IF(IRETRY- 4)  68, 68, 208                                         06H0160
 208  WRITE OUTPUT TAPE ITO,210                                          06H0161
 210  FORMAT(69H THE SYSTEM HAS BEEN RETRIED  4  TIMES W9THOUT SUCCESS,J06H0162
     *OB TERMINATED)                                                    06H0163
      GO TO 2216                                                         06H0165
 216  NF=NF+1                                                            06H0166
      REWIND ITG                                                         06H0167
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      CALL CHAIN(1,ITA)                                                 06H0168
212   WRITE OUTPUT TAPE ITO,214                                         06H0169
214   FORMAT(56H THE JOB CANNOT CONVERGE AT INITIAL POINT,JOB TERMINATED06H0170
     *)                                                                 06H0171
      GO TO 216                                                         06H0172
1200  IF(ILOOP-2) 1202, 1202, 2200                                      06H0173
1202  IF(TRESET-TEMP) 1210,1212,1210                                    06H0174
1210  TEMP=TEMP-TDECR                                                   06H0175
      GO TO 68                                                          06H0176
1212  WRITE TAPE ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITA06H0177
     *TE(I),I=1,ND),((BIBLE(I,J),I=1,NA),J=1,NA),(IMAJOR(I),PARRAY(I),I=06H0178
     *1,NA)                                                             06H0179
      ITEMP=0                                                           06H0180
      PREF=0.                                                           06H0181
      DO 1214 I=1,NG                                                    06H0182
1214  PREF=PREF+PRESS(I)                                                06H0183
      DO 1216 I=1,ND                                                    06H0184
1216  YJ(I)=PRESS(I)/BIGA                                               06H0185
      IRETRY=0                                                          06H0186
      IDONE=IDONE+1                                                     06H0187
      IONG=IONG+1                                                       06H0188
2200  SIGH=0.                                                           06H0189
      SIGS=0.                                                           06H0190
      DO 2206 I=1,ND                                                    06H0191
      DJ(I)=(PRESS(I)/TEMP)*7.340389E+21
      IF(MASKPR(I)) 2206,2202,2206                                      06H0192
2202  SIGS=SIGS+CPHSDK(3,I)*PRESS(I)                                    06H0193
      SIGH=SIGH+CPHSDK(2,I)*PRESS(I)                                    06H0194
      IF(ITATE(I)-1) 2206,2204,2206                                     06H0195
2204  SIGS=SIGS-1.98725*PRESS(I)*PLN(I)                                 06H0196
2206  CONTINUE                                                          06H0197
      SIGH=SIGH/BIGA                                                    06H0198
      SIGS=SIGS/BIGA                                                    06H0199
      POUT=PREF*14.696006                                               06H0200
      RHO=BIGA/(82.0597*TEMP)                                           06H0201
2424  SUM=0.                                                            06H0202
      DO 2426 I=1,ND                                                    06H0203
2426  SUM=SUM+PRESS(I)                                                  06H0204
      DO 2428 I=1,ND                                                    06H0205
      XIP(I)=PRESS(I)/SUM                                               06H0206
2428  F(I)=CPHSDK(2,I)-1.E-3*TEMP*CPHSDK(3,I)                           06H0207
```

```
      CPBAR=0.                                                          06H0208
      DO 2430 I=1,NG                                                    06H0209
 2430 CPBAR=CPBAR+CPHSDK(1,I)*PRESS(I)                                  06H0210
      CPBAR=CPBAR/BIGA                                                  06H0211
      AVMOL=BIGA/PREF                                                   06H0212
      IF(KE-1) 2446, 2446, 2442                                         06H0213
 2442 WRITE OUTPUT TAPE ITO, 2444, PREF,POLD                            06H0214
 2444 FORMAT( 84H1 THE SYSTEM HAS LOST A DEGREE OF FREEDOM,RESULTING IN 06H0215
     *SINGULAR CORRECTION MATRICES./ 86 H  THE SYSTEM PRESSURE IS DEPEND06H0216
     *ENT ON CONDENSIBLE SPECIES AND THEIR PARTIAL PRESSURES./ 72H  THER06H0217
     *EFORE THE SYSTEM PRESSURE BECOMES A VARIABLE. THE NEW PRESSURE IS 06H0218
     * E16.8/ 37H  THE OLD OR LAST SYSTEM PRESSURE WAS  E16.8)          06H0219
      GO TO 2213                                                        06H0220
 2446 IF( ILOOP-2) 2207, 2300, 2400                                     06H0221
 2207 WRITE OUTPUT TAPE ITO,2208,POUT,TEMP,SIGS,SIGM,RHO                06H0222
C     MOLLIER DIAGRAM OUTPUT          **********************************06H0223
 2208 FORMAT( 9H P(PSIA)=E13.5,10H T(DEG-K)= F7.2,15H S(CAL/GM-DEG)=F7.406H0224
     *,12H H(KCAL/GM)= F8.4,15H RHO(GM/CU-CM)=E12.6)                    06H0225
      DO 2214 I=NG,ND                                                   06H0226
      IF(ITATE(I)-1) 2214,2214,2210                                     06H0227
 2210 WRITE OUTPUT TAPE ITO,2212,(NAME(J,I),J=1,2)                      06H0228
 2212 FORMAT(10X,2A6, 9H  PRESENT)                                      06H0229
 2214 CONTINUE                                                          06H0230
 2213 TDECR=ABSF(ABLOCK(5))                                             06H0231
      IRETRY=0                                                          06H0232
      PREF=POLD                                                         06H0233
      IF(TEMP-TFINAL)  2216, 2216, 2215                                 06H0234
 2215 TEMP=TEMP-TDECR                                                   06H0235
      TRESET=TEMP                                                       06H0236
      IF(TEMP-TFINAL) 2218,   68, 68                                    06H0237
 2216 IF(PREF-PFINAL) 216, 216, 2222                                    06H0238
 2218 TEMP=TFINAL                                                       06H0239
      TRESET=TEMP                                                       06H0240
      GO TO 68                                                          06H0241
 2222 REWIND ITG                                                        06H0242
      PREF=PREF/10.                                                     06H0243
      IRETRY=-1                                                         06H0244
      IONG=0                                                            06H0245
      TEMP=ABLOCK(3)                                                    06H0246
      TRESET = TEMP                                                     06H0247
      IM=0                                                              06H02472
```

```
      GO TO 66                                                                  06H0248
 2300 CONTINUE                                                                  06H0249
C     START EQUILIBRIUM GAS OPTION                                              06H0250
      WRITE OUTPUT TAPE ITO,406,TAPID(1),TAPID(2),IE,TITLE,PREF,TEMP,HC,06H0251
     *SIGH,SIGS,CPBAR,                                                          06H0252
     *              ((NAME(I,J),I=1,2),XIP(J),YJ(J),PRESS(J),CPHSDK(1,J06H0253
     *),DJ(J)       ,CPHSDK(3,J),F(J),J=1,ND)                                  06H0254
 406  FORMAT(1H1,5X, 5HTAPE ,2A6,68X,5HPAGE I2/1X,18A6//40X,14HPRESSURE 06H0255
     *(ATM),E15.6/41X,19HTEMPERATURE (DEG K),F8.2/27X,46HAVAILABLE NON-H06H0256
     *EATED SYSTEM ENTHALPY (KCAL/GM),F8.4/        38X,25HSYSTEM ENTHALPY06H0257
     * (KCAL/GM),F8.4/37X,27HSYSTEM ENTROPY (CAL/GM-DEG),F8.4/44X,13HSYS06H0258
     *TEM GAS CP,F8.5//4X,7HPRODUCT,4X,13HMOLE FRACTION,8X,5HMOLES,6X,  06H0259
     *16HPARTIAL PRESSURE,5X,2HCP,6X,8HATOMS/CC,5X,7HENTROPY,6X,4HH-TS//06H0260
     *(2X,2A6,E14.6,   E16.8,   E17.8,F11.4,E14.6,2F11.4)   )                  06H0261
      IE=IE+1                                                                   06H0262
      GO TO 2213                                                                06H0263
 2400 WRITE TAPE ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITA06H0264
     *TE(I),I=1,ND),((BIBLE(I,J),I=1,NA),J=1,NA),(IMAJOR(I),PARRAY(I),I=06H0265
     *1,NA)                                                                     06H0266
      REWIND ITG                                                                06H0267
C    START FLAME BURNING OPTION                                                 06H0268
      DO 2432  I=1,ND                                                           06H0269
 2432 DJ(I)=PRESS(I)/BIGA                                                       06H0270
      WRITE OUTPUT TAPE ITO,2434,(TAPID(I),I=1,2),TITLE,POUT,TEMP,SIGH,S06H0271
     *IGS,CPBAR,AVMOL,((NAME(I,J),I=1,2),DJ(J),XIP(J),CPHSDK(1,J),CPHSDK06H0272
     *(2,J),CPHSDK(3,J),F(J),J=1,ND)                                            06H0273
 2434 FORMAT( 1H1,43X,21HAEROSPACE CORPORATION/41X,26HFLAME TEMPERATURE 06H0274
     *SOLUTION/ 7H  TAPE  ,2A6/2X,18A6//40X,15HPRESSURE(PSIA) ,F12.6/39X06H0275
     *,19HTEMPERATURE(DEG-K) ,F11.6/39X,18HENTHALPY(KCAL/GM) ,F12.6/38X 06H0276
     *,21HENTROPY(CAL/GM-DEG K) ,F11.6/41X,14HAVERAGE GAS CP ,F12.6/37X,06H0277
     *23HAVERAGE GAS MOLE WEIGHT ,F11.6//2X, 7HPRODUCT,11X,5HMOLES,6X,13O6H0278
     *HMOLE FRACTION,11X,2HCP,14X,1HH,14X,1HS,14X,4HH-TS//(2X,2A6,2E15.606H0279
     *,4F16.5))                                                                 06H0280
      GO TO 216                                                                 06H0281
      END                                                                       06H0282
```

```
      SUBROUTINE AEROSP (ITO)                                                   01H0114
      WRITE OUTPUT TAPE ITO,2                                                   01H0115
2     FORMAT(1H1,///// 52X,5(1HA),48X,4(1HA),5X,4(1HA)/45X,3HAAA,13X,3HA01H0116
     *AA/ 44X,1HA,14X,2HAA,3X1HA/ 43X, 1HA,13X,4HAAAA,4X,1HA/43X,1HA,11X01H0117
     *,6HAA  AA,4X,1HA/ 42X,1HA,10X,2HAA,4X,2HAA,5X,1HA/42X,1HA,8X,10(1H01H0118
     *A),5X,1HA/42X,1HA,6X,12(1HA),5X,1HA/43X,1HA,3X,2HAA,10X,2HAA,4X,1H01H0119
     *A/43X,4HA AA12X,2HAA,4X,1HA/44X,1HA,19X,1HA/46X,3HAAA,13X,3HAAA/48 01H0120
     *X,4HAAAA,5X4HAAAA/52X,5(1HA)////)                                         01H0121
      WRITE OUTPUT TAPE ITO,4                                                   01H0122
4     FORMAT(29X,2HNN,5X4HNN  5(1HE),21X,6(1HS),4X,8(1HT)/29X,4HNNNN,3X,01H0123
     *4HNN  ,5(1HE),20X,3HSSS,2X,3HSSS,3X,8(1HT)/29X,5(1HN),2X,4HNN  ,  01H0124
     *2HEE,23X,2HSS,4X,2HSS,6X,2HTT/29X, 6HNN NNN,5H NN  ,2HEE,23X,3HSSS01H0125
     *,11X,2HTT/29X,2HNN,2X,5(1HN),2X,4HEEEE,1X,18HLEMENT   CHEMISTRY,3X01H0126
     *,6(1HS),4H  YS,3X,2HTT,3X,2HEM/29X,2HNN,3X,4HNNNN,2X,4HEEEE,23X,6(01H0127
     *1HS),6X,2HTT/29X,2HNN,4X,3HNNN,2X,2HEE,29X,2HSS,6X,2HTT/29X,2HNN,501H0128
     *X,2HNN,2X,2HEE,22X,3HSSS,3X,3HSSS,6X,2HTT/29X,2HNN,5X,4HNN  ,6(1HE01H0129
     *),19X,7(1HS),7X,2HTT/29X,2HNN,5X,4HNN  ,6(1HE),20X,5(1HS),8X,2HTT)01H0130
      RETURN                                                                    01H0131
      END                                                                       01H0132
```

```
C       SUBROUTINE SELECT                                                       01H1039
        SUBROUTINE SELECT                                                       01H1040
        DIMENSION A(40,41), ANS(40), BIBLF(15,15) , COEFS(15,151), DATA(        01H1041
       * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(         01H1042
       * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),        01H1043
       * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1044
       * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1045
       * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)                01H1046
C         11 / 15/ 61                                                           01H1047
        COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBUC1H1048
       *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1049
       * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H1050
       * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITJ, ITATE, IBREAK, IMAJOR,    01H1051
       * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,   01H1052
       * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H1053
       * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H1054
       * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                     01H1055
        DIMENSION NM(2),CM(50)                                                  01H1056
 4      DO 5 I=1,150                                                           01H1057
 5      MASKPR(I)=0                                                            01H1058
        IF(IP)   6,42,6                                                        01H1059
C       IP=1 CHOOSE ALL BUT FFG                                                01H1060
C       IP=0 CHOOSE ALL                                                        01H1061
C       IP=-1 CHOOSE ONLY FFG                                                  01H1062
 6      READ INPUT TAPE ITI,8,N                                                01H1063
 8      FORMAT(I12)                                                            01H1064
        DO 36 I=1,N                                                            01H1065
        READ INPUT TAPE ITI,2,NM,KK                                            01H1066
 2      FORMAT(2A6,I2)                                                         01H1067
        DO 34 J=1,ND                                                           01H1068
        IF(NM(1)-NAME(1,J)) 34, 10, 34                                         01H1069
 10     IF(NM(2)-NAME(2,J)) 34, 12, 34                                         01H1070
 12     IF(ABSF(KK) -ABSF( ITATE(J))) 34, 29, 34                               01H1071
 29     IF(IP)32,32,30                                                         01H1072
 30     MASKPR(J)=1                                                            01H1073
        GO TO 34                                                               01H1074
 32     MASKPR(J)=-1                                                           01H1075
 34     CONTINUE                                                               01H1076
 36     CONTINUE                                                               01H1077
        IF(IP)38,42,42                                                         01H1078
 38     DO 40 J=1,ND                                                           01H1079
```

```
40    MASKPR(J)=MASKPR(J)+1                                              01M1080
42    IF(IQ)44,46,44                                                     01M1081
44    RETURN                                                             01M1082
46    WRITE OUTPUT TAPE ITO,48                                           01M1083
48    FORMAT(1H1,10(1H*),34H PRODUCTS CHOSEN ARE THE FOLLOWING//)        01M1084
      DO54I=1,ND                                                         01M1085
      IF(MASKPR(I))54,50,54                                              01M1086
50    WRITE OUTPUT TAPE ITO,52,NAME(1,I),NAME(2,I),WORK(I)               01M1087
52    FORMAT(25X,2A6,10X,17HHEAT OF FORMATION,F16.4)                     01M1088
54    CONTINUE                                                           01M1089
      GO TO 44                                                           01M1090
      END                                                                01M1091
```

```
C     SUBROUTINE INPUT1                                                 01H0567
C        ************** UPDATED 2/14/63                                 01H0568
      SUBROUTINE INPUT1(L)                                              01H0569
C        THIS SUBROUTINE COMBINES THE INGREDIENTS IN WEIGHT PERCENT     01H0570
C          MOLES OR MOLE PERCENT                                        01H0571
C*****************************************************************     01H0572
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H0573
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H0574
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),   01H0575
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H0576
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H0577
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H0578
C      11 / 15/ 61                                                      01H0579
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H0580
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H0581
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H0582
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H0583
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H0584
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H0585
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H0586
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY               01H0587
      DIMENSION HEACH(15),NOEL(15),NAMELS(15,15), Q(50),                01H0588
     *CL(15,15),WEIGHT(50),T(15,4)                                      01H0589
      IF(NF)1,1,28                                                      01H0590
C     NF IS THE COUNTER FOR COMPLETED ANS SETS ************************01H0591
    1 DO 2 I=1,IK                                                       01H0592
      CALL LOOKA(1,0,ITI,ITO)                                           01H0593
      READ INPUT TAPE ITI,4,(T(I,J),J=1,4),HEACH(I),                    01H0594
     *NOEL(I)                                                           01H0595
      N=NOEL(I)                                                         01H0596
                                                                        01H0597
      CALL LOOKA(1,0,ITI,ITO)                                           01H0598
    2 READ INPUT TAPE ITI,6,(NAMELS(I,J),CL(I,J),J=1,N)                 01H0599
    4 FORMAT(4A6,F12.5,I6)                                              01H0600
    6 FORMAT(6(A2,F10.5))                                               01H0601
      READ TAPE ITD,TAPID(1),TAPID(2),IN,IO,(NEL(I),HEL(I),             01H0602
     *I=1,IN)                                                           01H0603
      IG=0                                                              01H0604
C     IG SET FOR NEW PROBLEM ******************************************01H0605
      DO 8 I=1,100                                                      01H0606
      MASKEL(I)=0                                                       01H0607
```

```
      WORK(I)=0.                                                        01H0608
                                                                        01H0609
  8   CONTINUE                                                          01H0610
      DO 16 I=1,IK                                                      01H0611
      WEIGHT(I)=0.                                                      01H0612
      N=NOEL(I)                                                         01H0613
      DO 16 J=1,N                                                       01H0614
      CALL SHIFT(1,NAMELS(I,J),W)                                       01H0615
      CALL PERIOD(NAMELS(I,J),W,X1,X2,ERROR)                            01H0616
      IF(ERROR)100,10,100                                               01H0617
 10   WEIGHT(I)=WEIGHT(I)+W*CL(I,J)                                     01H0618
C     WEIGHT IN GRAMS/MOLE                                              01H0619
C     EACH FUEL WEIGHT IS COMPUTED ***************************************01H0620
      DO 14 K=1,IN                                                      01H0621
      IF(NAMELS(I,J)-NEL(K)) 14, 12, 14                                 01H0622
 12   MASKEL(K)=1                                                       01H0623
      HEACH(I)=HEACH(I)+HEL(K)*CL(I,J)                                  01H0624
C     CORRECT THE INPUT HEAT OF FORMATION FOR THE TAPE BASES            01H0625
      GO TO 16                                                          01H0626
 14   CONTINUE                                                          01H0627
      GO TO 102                                                         01H0628
 16   CONTINUE                                                          01H0629
      NA=0                                                              01H0630
      DO 20 I=1,IN                                                      01H0631
      IF(MASKEL(I))18,20,18                                             01H0632
 18   NA=NA+1                                                           01H0633
 20   CONTINUE                                                          01H0634
      DO 22 I=1,IK                                                      01H0635
      N=NOEL(I)                                                         01H0636
      WRITE TAPE ITC,(T(I,J),J=1,4),HEACH(I),                           01H0637
     *NOEL(I)                                                           01H0638
 22   WRITE TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)                        01H0639
 24   WRITE TAPE ITC,(WEIGHT(I),I=1,IK)                                 01H0640
C     THERE ARE IK+1 RECORDS ON ITC NOW. NEXT PROB.                     01H0641
C     THEY ARE READ FROM HERE RATHER THAN REDONE **************************01H0642
      CALL SIFTIT(L)                                                    01H0643
      IF(L)104,26,104                                                   01H0644
 26   REWIND ITD                                                        01H0645
      CALL SELECT                                                       01H0646
      GO TO 32                                                          01H0647
C28   BOX(A) **************************************************************01H0648
```

```
 28   REWIND ITC                                                          01H0649
      DO 30 I=1,IK                                                        01H0650
      READ TAPE ITC,(T(I,J),J=1,4),HEACH(I),NOEL(I)                       01H0651
      N=NOEL(I)                                                           01H0652
 30   READ TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)                           01H0653
      READ TAPE ITC,(WEIGHT(I),I=1,IK)                                    01H0654
 32   REWIND ITC                                                          01H0655
C     READ FUEL SPECIFICATION CARDS ***************************************01H0656
      CALL LOOKA(1,0,ITI,ITO)                                             01H0657
      READ INPUT TAPE ITI,34,(Q(I),I=1,IK)                                01H0658
 34   FORMAT(6E12.8)                                                      01H0659
      DO 38 I=1,IK                                                        01H0660
      DO 36 J=1,IK                                                        01H0661
 36   A(I,J)=0.                                                           01H0662
      A(I,I)=WEIGHT(I)                                                    01H0663
 38   A(IK+1,I)=1.                                                        01H0664
      SL=0.                                                               01H0665
      IKP1=IK+1                                                           01H0666
      GO TO (40,40,46),IH                                                 01H0667
C40   MOLES OR MOLE PERCENT ************************************************01H0668
 40   DO 42 I=1,IK                                                        01H0669
 42   SL=SL+Q(I)*WEIGHT(I)                                                01H0670
      DO 44 I=1,IK                                                        01H0671
      WORK(I)=Q(I)*WEIGHT(I)/SL                                           01H0672
 44   A(I,IKP1)=-WORK(I)                                                  01H0673
      GO TO 52                                                            01H0674
C46   WEIGHT PERCENT ********************************************************01H0675
 46   DO 48 I=1,IK                                                        01H0676
 48   SL=SL+Q(I)                                                          01H0677
      DO 50 I=1,IK                                                        01H0678
      WORK(I)=Q(I)/SL*100.                                                01H0679
 50   A(I,IKP1)=-WORK(I)/100.                                             01H0680
 52   A(IKP1,IKP1)=0.                                                     01H0681
      CALL INVRS(A,IKP1,TEST,DETER)                                       01H0682
      WORK(IKP1)=A(IKP1,IKP1)*100.                                        01H0683
      G=100.                                                              01H0684
      SUM=0.                                                              01H0685
      DO 51 I=1,IK                                                        01H0686
      IF(A(I,IKP1)) 512, 512, 510                                         01H0687
510   G=MIN1F(G,A(I,IKP1))                                                01H0688
512   WORK(I)=100.*A(I,IKP1)*WEIGHT(I)/A(IKP1,IKP1)                       01H0689
```

```
 51   WORK(I+32)=A(I,IKP1)*100.                                          01H0690
      DO 49 I=1,IK                                                       01H0691
 49   WORK(I+16)=A(I,IKP1)/G                                             01H0692
      HC=0.                                                              01H0693
C     WORK(1-15)=WEIGHT PERCENTS                                         01H0694
C     WORK(16-31)=NORMALIZED MOLES                                       01H0695
C     WORK(32-45)=MOLE PERCENTS*******************************************01H0696
      AA=0.                                                              01H0697
      SL=0.                                                              01H0698
      DO 54 I=1,IK                                                       01H0699
      HC=HC+HEACH(I)*A(I,IKP1)                                           01H0700
      ANS(I)=WEIGHT(I)*A(I,IKP1)                                         01H0701
 54   SL=SL+ANS(I)                                                       01H0702
C     HC=SUMMATION(ENTHALPY OF EACH*WEIGHT FRACTION)                     01H0703
C     ANS=WEIGHT(GRAMS) OF EACH FUEL USED                                01H0704
C     SL=TOTAL SYSTEM REACTANTS WEIGHT ************************************01H0705
      HCMOLE=HC                                                          01H0706
      HC=HC/SL                                                           01H0707
C     HC IS NOW IN KCAL/MOLE REACTANTS ************************************01H0708
      N=1                                                                01H0709
      DO 58 I=1,IN                                                       01H0710
      IF(MASKEL(I))56,58,56                                              01H0711
 56   CALL PERIOD(NEL(I),W,X1,X2,ERROR)                                  01H0712
      FG(N)=X1                                                           01H0713
      N=N+1                                                              01H0714
 58   CONTINUE                                                           01H0715
      L=1                                                                01H0716
      DO 57 I=1,NA                                                       01H0717
 57   WORK(I+50)=0.                                                      01H0718
      DO 60 I=1,NA                                                       01H0719
      BM(I)=0.                                                           01H0720
      DO 60 J=1,IK                                                       01H0721
      N=NOEL(J)                                                          01H0722
      DO 60 JJ=1,N                                                       01H0723
      IF(NAME (1,I)-NAMELS(J,JJ)) 60,59,60                               01H0724
 59   BM(I)=BM(I)+ANS(J)*CL(J,JJ)/(WEIGHT(J)*SL)                         01H0725
      WORK(I+50)=WORK(I+50)+CL(J,JJ)*A(J,IKP1)                           01H0726
 60   CONTINUE                                                           01H0727
C     WORK(50-75)-CONTAINS ATOMS PER ELEMENT I                           01H0728
      WRITE OUTPUT TAPE ITO,62,(TAPID(I),I=1,2),TITLE,((T(I,J),J=1,4),   01H0729
     *WORK(I),WORK(I+16),WORK(I+32),I=1,IK)                              01H0730
```

```
 62   FORMAT(1H1,44X,21HAEROSPACE CORPORATION/1X,    2A6/1X,18A6//12X,  01H0731
     *9HCOMPONENT,12X,14HWEIGHT PERCENT,15X,5HMOLES,16X,12HMOLE PERCENT 01H0732
     *//(8X,4A6,F12.6,4X,F21.6,F24.6))                                  01H0733
      WRITE OUTPUT TAPE ITO,64,(NAME (1,I),WORK(I+50),                 01H0734
     *BM(I),I=1,NA)                                                    01H0735
 64   FORMAT(1X//20X,8HELEMENTS,18X,5HMOLES,17X,23HMASS BALANCE (MOLES/G01H0736
     *M)//(21X,A6,F24.4,18X,E16.8))                                    01H0737
 68   FORMAT( 8X,9HCOMPONENT,5X,4A6,19H NUMBER OF ELEMENTS,I3,          01H0738
     *31H HEAT OF FORMATION (KCAL/MOLE)=F8.3)                          01H0739
 69   FORMAT(8X,10(A2,F6.4,2X))                                         01H0740
      WRITE OUTPUT TAPE ITO,701                                         01H0741
 701  FORMAT(1H1)                                                       01H0742
      L=1                                                               01H0743
      RETURN                                                            01H0744
C     RESET ELEMENT MASK FOR NEW PROBLEM ***************************** 01H0745
 100  WRITE OUTPUT TAPE ITO,101                                         01H0746
C     ERROR IN FINDING INPUT ELEMENT NAME ************************** 01H0747
 101  FORMAT(40H ERROR IN INPUT DATA -ELEMENT NOT LISTED//)             01H0748
      GO TO 106                                                         01H0749
 102  WRITE OUTPUT TAPE ITO,103                                         01H0750
 103  FORMAT(47H ERROR IN INPUT DATA -INPUT ELEMENT NOT ON TAPE)        01H0751
      GO TO 106                                                         01H0752
 104  WRITE OUTPUT TAPE ITO,105                                         01H0753
 105  FORMAT(41H ERROR IN INITIAL TAPE SORT PROB. BAD TAPE//)           01H0754
 106  L=2                                                               01H0755
      CALL DUMP2(12.)                                                   01H0756
      RETURN                                                            01H0757
      END                                                               01H0758
```

```
C      SUBROUTINE INPUT2                                                    01H0775
C         ************** UPDATED 2/14/63                                    01H0776
       SUBROUTINE INPUT2(L)                                                 01H0777
C         THIS SUBROUTNE COMBINES INGREDIENTS SPECIFIED IN MIXTURE         01H0778
C         RATIO AND OXIDIZER RATIO                                         01H0779
C*************************************************************************01H0780
       DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(    01H0781
      * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(     01H0782
      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),     01H0783
      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H0784
      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H0785
      * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)           01H0786
C        11 / 15/ 61                                                      01H0787
       COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H0788
      *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H0789
      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H0790
      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    01H0791
      * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H0792
      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,  01H0793
      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H0794
      * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H0795
       DIMENSION MEACH(15),NOEL(15),NAMELS(15,15),Q(50),CL(15,15),WEIGHT(01H0796
      *50),T(15,4)                                                       01H0797
       IF(NF) 1,1,34                                                     01H0798
C      NF IS THE COUNTER FOR COMPLETED ANSWER SETS **********************01H0799
 1     DO 2 I=1,IK                                                       01H0800
       CALL LOOKA(1,0,ITI,ITO)                                           01H0801
       READ INPUT TAPE ITI,4,(T(I,J),J=1,4),MEACH(I),NOEL(I)             01H0802
       N=NOEL(I)                                                         01H0803
       CALL LOOKA(1,0,ITI,ITO)                                           01H0804
 2     READ INPUT TAPE ITI,6,(NAMELS(I,J),CL(I,J),J=1,N)                 01H0805
 4     FORMAT(4A6,F12.5,I6)                                              01H0806
 6     FORMAT(6(A2,F10.5))                                               01H0807
       READ TAPE ITD,(TAPID(I),I=1,2),IN,IO,(NEL(I),HEL(I),I=1,IN)       01H0808
       IG=0                                                              01H0809
C      IG SET FOR NEW PROBLEM                                            01H0810
       DO 8 I=1,100                                                      01H0811
       MASKEL(I)=0                                                       01H0812
 8     WORK(I)=0                                                         01H0813
       DO604 I=1,IK                                                      01H0814
       N=NOEL(I)                                                         01H0815
```

```
      DO604 J=1,N                                                       01H0816
      DO602 K=1,IN                                                      01H0817
      CALL SHIFT(1,NAMELS(I,J),W)                                       01H0818
      IF(NAMELS(I,J)-NEL(K)) 602,600,602                                01H0819
600   MASKEL(K)=1                                                       01H0820
      HEACH(I)=HEACH(I)+HEL(K)*CL(I,J)                                  01H0821
      GO TO 604                                                         01H0822
602   CONTINUE                                                          01H0823
604   CONTINUE                                                          01H0824
      NA=0                                                              01H0825
      DO 608 I=1,IN                                                     01H0826
      IF(MASKEL(I)) 606,608,606                                         01H0827
606   NA=NA+1                                                           01H0828
608   CONTINUE                                                          01H0829
      W=0.                                                              01H0830
      X=0.                                                              01H0831
      Y=0.                                                              01H0832
      Z=0.                                                              01H0833
      WO=0.                                                             01H0834
      WF=0.                                                             01H0835
      ON=0.                                                             01H0836
      FN=0.                                                             01H0837
      CALL CHANGE(A1,6HFUEL  )                                          01H0838
      CALL SHIFT(1,T(1,4),T(1,4))                                       01H0839
      IF(A1-T(1,4))  12, 10, 12                                         01H0840
10    IFUEL=1                                                           01H0841
      IOX=2                                                             01H0842
      GO TO 14                                                          01H0843
12    IFUEL=2                                                           01H0844
      IOX=1                                                             01H0845
14    N=NOEL (IFUEL)                                                    01H0846
      DO  22 J=1,N                                                      01H0847
      CALL SHIFT(1,NAMELS(IFUEL,J),W1)                                  01H0848
      CALL PERIOD(NAMELS(IFUEL,J),WT,X1,VAL,ERWD)                       01H0849
      IF(ERWD) 500,16,500                                               01H0850
16    IF(VAL) 18,20,20                                                  01H0851
18    W=W-VAL*CL(IFUEL,J)                                               01H0852
      GO TO 22                                                          01H0853
20    Y=Y+VAL*CL(IFUEL,J)                                               01H0854
22    WF=WF+CL(IFUEL,J)*WT                                              01H0855
      N=NOEL (IOX)                                                      01H0856
```

```
      DO  30 J=1,N                                                      01H0857
      CALL SHIFT(1,NAMELS(IOX,J),W1)                                    01H0858
      CALL PERIOD(NAMELS(IOX,J),WT,X1, VAL,ERWD)                        01H0859
      IF(ERWD) 510,24,510                                               01H0860
 24   IF(VAL) 26,28,28                                                  01H0861
 26   X=X-VAL*CL(IOX,J)                                                 01H0862
      GO TO 30                                                          01H0863
 28   Z=Z+VAL*CL(IOX,J)                                                 01H0864
 30   WO=WO+CL(IOX,J)*WT                                                01H0865
C     IF IH=4 -INPUT IS MIXTURE RATIO  ********************************01H0866
C     IF IH=5 -INPUT IS OXIDIZER RATIO ********************************01H0867
      DO 32 I=1,IK                                                      01H0868
      N=NOEL(I)                                                         01H0869
      WRITE TAPE ITC,(T(I,J),J=1,4),HEACH(I),NOEL(I)                    01H0870
 32   WRITE TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)                        01H0871
      WRITE TAPE ITC,WF,WO,W,X,Y,Z ,IFUEL,IOX                           01H0872
      CALL SIFTIT(L)                                                    01H0873
      REWIND ITD                                                        01H0874
      CALL SELECT                                                       01H0875
      GO TO 38                                                          01H0876
 34   REWIND ITC                                                        01H0877
      DO 36  I=1,IK                                                     01H0878
      READ TAPE ITC,(T(I,J),J=1,4),HEACH(I),NOEL(I)                     01H0879
      N=NOEL(I)                                                         01H0880
 36   READ TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)                         01H0881
      READ TAPE ITC,WF,WO,W,X,Y,Z,IFUEL,IOX                             01H0882
 38   REWIND ITC                                                        01H0883
      CALL LOOKA(1,0,ITI,ITO)                                           01H0884
      READ INPUT TAPE ITI,40,RATIO                                      01H0885
      IF(IH-4)42,42,44                                                  01H0886
 42   RM=RATIO                                                          01H0887
      OR=0.                                                             01H0888
      GO TO 46                                                          01H0889
 44   RM=0.                                                             01H0890
      OR=RATIO                                                          01H0891
 46   ALPHA=(X-Z*OR)/((Y-Z)*OR+X-W)                                     01H0892
      BETA=1.-ALPHA                                                     01H0893
      IF(RM)990,48,50                                                   01H0894
 48   RM=(BETA/ALPHA)*(WO/WF)                                           01H0895
      GO TO 52                                                          01H0896
 50   OR= (X*RM*WF/WO+W)/(Z*RM*WF/WO+Y)                                 01H0897
```

```
      FN=(1.-RM/(RM+1.))/WF                                                 01H0898
      ON=(RM/(RM+1.))/WO                                                    01H0899
      HC=HEACH(IFUEL)*FN+HEACH(IOX)*ON                                      01H0900
      N=1                                                                   01H0901
      DO  72 I=1,NA                                                         01H0902
      WORK(I)=0.                                                            01H0903
      WORK(I+15)=0.                                                         01H0904
      BM(I)=0.                                                              01H0905
   54 N1=NOEL(IFUEL)                                                        01H0906
      DO  58  K=1,N1                                                        01H0907
      IF(NAME(1,I)-NAMELS(IFUEL,K)) 58, 56, 58                              01H0908
   56 BM(I)=BM(I)+FN*CL(IFUEL,K)                                            01H0909
      WORK(I)=WORK(I)+CL(IFUEL,K)                                           01H0910
      GO TO 60                                                              01H0911
   58 CONTINUE                                                              01H0912
   60 N2=NOEL(IOX)                                                          01H0913
      DO  64  K=1,N2                                                        01H0914
      IF(NAME(1,I)-NAMELS(IOX,K)) 64, 62, 64                                01H0915
   62 BM(I)=BM(I)+ON*CL(IOX,K)                                              01H0916
      WORK(I+15)=WORK(I+15)+CL(IOX,K)                                       01H0917
      GO TO 72                                                              01H0918
   64 CONTINUE                                                              01H0919
   72 CONTINUE                                                              01H0920
      WRITE OUTPUT TAPE ITO,514,(TAPID(J),J=1,2),TITLE                      01H0921
  514 FORMAT(1H1,44X,21HAEROSPACE CORPORATION/1X,2A6/1X,18A6//)             01H0922
      WRITE OUTPUT TAPE ITO,516,(T(IFUEL,J),J=1,4),(T(IOX,J),J=1,4),RM,O01H0923
     *R                                                                     01H0924
      DO 90 I=1,NA                                                          01H0925
      M=I+15                                                                01H0926
   90 WRITE OUTPUT TAPE ITO,518,NAME(1,I),WORK(I),WORK(M),BM(I)             01H0927
      L=1                                                                   01H0928
      WRITE OUTPUT TAPE ITO,994                                             01H0929
  994 FORMAT(1H1)                                                           01H0930
      RETURN                                                                01H0931
  516 FORMAT(35X,14HFUEL COMPONENT,2X,4A6/33X,18HOXIDIZER COMPONENT,2X,401H0932
     *A6//39X,13HMIXTURE RATIO,5X,14HOXIDIZER RATIO/43X,F8.5,11X,F8.5///01H0933
     *11X,15HSYSTEM ELEMENTS,6X,12HFUEL FORMULA,5X,16HOXIDIZER FORMULA,501H0934
     *X,30HMASS BALANCE (MOLES/SYSTEM-GM)//)                             01H0935
   40 FORMAT(E12.8)                                                         01H0936
  518 FORMAT(12X,A6,15X,F10.5,9X,F10.5,13X,E16.8)                           01H0937
  500 WRITE OUTPUT TAPE ITO,502                                             01H0938
```

```
502  FORMAT( 56H1 A FUEL ELEMENT IS NOT IN SUBROUTINE PERIOD,JOB DELETE01H0939
    *D)                                                                01H0940
504  L=2                                                               01H0941
     RETURN                                                            01H0942
510  WRITE OUTPUT TAPE ITO,512                                         01H0943
512  FORMAT( 61H1 AN OXIDIZER ELEMENT IS NOT IN SUBROUTINE PERIOD,JOB D01H0944
    *ELETED)                                                           01H0945
     GO TO 504                                                         01H0946
990  WRITE OUTPUT TAPE ITO,992                                         01H0947
992  FORMAT( 55H1  ERROR IN COMPUTING MIXTURE RATIO FROM OXIDIZER RATIO01H0948
    */58H      PROBLEM IS DELETED . CHECK INPUT DATA AND RESUBMIT ./1H101H0949
    *)                                                                 01H0950
     L=2                                                               01H0951
     RETURN                                                            01H0952
     END                                                               01H0953
```

```
*       FAP                                                          01H0954
*                                                                    01H0955
*             CALLING SEQUENCE                                       01H0956
*             CALL PERIOD(ELEMENT NAME,WEIGHT,FIRST                  01H0957
*                                 GUESS,VALANCE,ERROR)               01H0958
*                                                                    01H0959
*             ERROR=0 NORMALLY,IF=1 NO CAN FIND                      01H0960
        ENTRY   PERIOD                                               01H0961
PERIOD  SXA     EXIT-1,1                                             01H0962
        AXT     ,1                                                   01H0963
        CLA     NAMES,1                                              01H0964
        SUB     END                                                  01H0965
        TZE     EXIT+1                                               01H0966
        ADD     END                                                  01H0967
        SUB*    1,4                                                  01H0968
        TZE     *+2                                                  01H0969
        TXI     PERIOD+2,1,-1                                        01H0970
        CLA     WEIGT,1                                              01H0971
        STO*    2,4                                                  01H0972
        CLA     FG,1                                                 01H0973
        STO*    3,4                                                  01H0974
        CLA     VAL,1                                                01H0975
        STO*    4,4                                                  01H0976
        STZ*    5,4                                                  01H0977
        AXT     ,1                                                   01H0978
EXIT    TRA     6,4                                                  01H0979
        CLA     *+3                                                  01H0980
        STO*    5,4                                                  01H0981
        TRA     EXIT-1                                               01H0982
        PZE     ,,1                                                  01H0983
 ZERO   PZE                                                          01H0984
NAMES   BCI     1,H                                                  01H0985
        BCI     1,HE                                                 01H0986
        BCI     1,LI                                                 01H0987
        BCI     1,BE                                                 01H0988
        BCI     1,B                                                  01H0989
        BCI     1,C                                                  01H0990
        BCI     1,N                                                  01H0991
        BCI     1,O                                                  01H0992
        BCI     1,F                                                  01H0993
        BCI     1,NE                                                 01H0994
        BCI     1,NA
        BCI     1,MG
```

```
            BCI     1,AL                                                    01H0995
            BCI     1,SI                                                    01H0996
            BCI     1,P                                                     01H0997
            BCI     1,S                                                     01H0998
            BCI     1,CL                                                    01H0999
            BCI     1,AR                                                    01H1000
            BCI     1,K                                                     01H1001
            BCI     1,CA                                                    01H1002
            BCI     1,SC                                                    01H1003
            BCI     1,TI                                                    01H1004
            BCI     1,CR                                                    01H1005
            BCI     1,FE                                                    01H1006
            BCI     1,CO                                                    C1H1007
            BCI     1,NI                                                    01H1008
            BCI     1,CU                                                    01H1009
            BCI     1,ZN                                                    01H1010
            BCI     1,BR                                                    01H1011
            BCI     1,AG                                                    01H1012
            BCI     1,CD                                                    01H1013
            BCI     1,I                                                     01H1014
            BCI     1,CS                                                    01H1015
            BCI     1,BA                                                    01H1016
            BCI     1,HG                                                    01H1017
            BCI     1,PB                                                    01H1018
            BCI     1,BI                                                    01H1019
            BCI     1,U                                                     01H1020
            BCI     1,E                                                     01H1021
 END        BCI     1,END                                                   01H1022
WEIGT       DEC     1.008,4.003,6.940,9.013,10.82,12.011,14.008             01H1023
            DEC     16.,19.,20.183,22.991,24.32,26.98,28.09                 01H1024
            DEC     30.975,32.066,35.457,39.944,39.100,40.08                01H1025
            DEC     44.96,47.90,52.01,55.85,58.94,58.69,63.54               01H1026
            DEC     65.38,79.916,107.88,112.41,126.91,132.91                01H1027
            DEC     137.36,200.61,207.21,209.,238.07,.00054847              01H1028
FG          DEC     .0028,1.,4.5E-4,2.E-5,8.1E-6,1.4E-10                    01H1029
            DEC     3.E-6,1.1E-5,.02,1.,1.2E-3,4.5E-4                       01H1030
            DEC     1.5E-7,1.E-6,.029,.079,1.E-6,.001,.001                  01H1031
            DEC     .001,.001,1.E-5,.001,.001,.001,.001                     01H1032
            DEC     .001,.001,.001,.001,.001,.001,.001                      01H1033
            DEC     .001,.001,.1,.001,.001,.001,.001                        01H1034
VAL         DEC     1.,0.,1.,2.,3.,4.,0.,-2.,-1.,0.,1.,2.,3.                01H1035
```

```
DEC     4.,0.,-6.,-1.,0.,1.,2.,3.,4.,6.,3.,3.,2.,2.          01M1036
DEC     2.,-1.,1.,2.,-1.,1.,2.,2.,2.,3.,6.,-1.               01M1037
END                                                          01M1038
```

```
*       FAP                                                              01M1092
*       CALL SEQ (1 OR 2,NAME1,NAME2)                                    01M1093
        ENTRY SHIFT                                                      01M1094
SHIFT   SXA     EXIT-1,1                                                 01M1095
        SXA     EXIT-2,2                                                 01M1096
        LDQ*    1,4                                                      01M1097
        MPY     =06                                                      01M1098
        PDX     ,1              6) OR 12 ) DEC IN IR 1                   01M1099
        PDX     ,2              6) OR 12 ) DEC IN IR 2                   01M1100
B       LDQ*    2,4                                                      01M1101
        LGL     6                                                        01M1102
        STO     A                                                        01M1103
        LGR     6                                                        01M1104
        CLA     A                                                        01M1105
        SUB     =060                                                     01M1106
        TNZ     EXIT-2                                                   01M1107
        CAL     OCT                                                      01M1108
        RQL     6                                                        01M1109
        STQ*    2,4                                                      01M1110
        TXI     *+1,1,-1                                                 01M1111
        TXL     C,2,7                                                    01M1112
        LDQ*    2,4                                                      01M1113
        LGR     6                                                        01M1114
        CAL*    3,4                                                      01M1115
        RQL     6                                                        01M1116
        STQ*    2,4                                                      01M1117
        LDQ*    3,4                                                      01M1118
        CAL     OCT                                                      01M1119
        RQL     6                                                        01M1120
        STQ*    3,4                                                      01M1121
C       TXH     B,1                                                      01M1122
        AXT     ,2                                                       01M1123
        AXT     ,1                                                       01M1124
EXIT    TRA     4,4                                                      01M1125
OCT     OCT     600000000000                                             01M1126
A       PZE                                                              01M1127
        END                                                              01M1128
```

```
C       SUBROUTINE CHECK                                                        01H1679
C          ************** UPDATED 2/14/63                                      01H1680
        SUBROUTINE CHECK(L)                                                     01H1681
        DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(        01H1682
       * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(        01H1683
       * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),       01H1684
       * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1685
       * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1686
       * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H1687
        DIMENSION DJ(150),YJ(150)                                               01H1688
C       1/19/62                                                                 01H1689
        COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBUC1H1690
       *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1691
       * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H1692
       * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H1693
       * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H1694
       * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H1695
       * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAYC1H1696
       * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H1697
       *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                          01H1698
C       REWRITTEN FOR MODE CONTROL                                              01H1699
C                 MODE1  REGULAR                                                01H1700
C                 MODE2  CONST TEMP                                             01H1701
C                 MODE3  DISCONTINUITY                                          01H1702
        MODE=MODE                                                               01H1703
 1      IF(MODE-2)  2 , 20 , 22                                                 01H1704
C       MODE1 CONTROL                                                           01H1705
 2      MODE=1                                                                  01H1706
        IF(KT-1)  6 ,4 ,6                                                       01H1707
 4      KT=0                                                                    01H1708
 5      ASSIGN 1   TO IGO                                                       01H1709
        GO TO 1000                                                              01H1710
 6      CONTINUE                                                                01H1711
C       MODE 1 ASSIGNMENTS ************************************************** 01H1712
        ASSIGN    8 TO IOUT1                                                    01H1713
        ASSIGN 1000 TO IOUT2                                                    01H1714
        ASSIGN  16  TO IGO                                                      01H1715
        ASSIGN 1010 TO IALTER                                                   01H1716
        GO TO 1004                                                              01H1717
 12     MODE=3                                                                  01H1718
C       ENTER MODE 3 CONTROL-DECISIONS TO THIS POINT ARE- (ONLY ENTRANCE)       01H1719
```

```
C                IN DISCONTINUITY                                          01H1720
C                MUST LOOP ONCE MORE-AT LEAST                              01H1721
C                FIRST-RESET TO CONSTANT TEMP AND REDO PROBLEM             01H1722
      ASSIGN  16   TO IGO                                                  01H1723
      GO TO 1000                                                           01H1724
 8    L=2                                                                  01H1725
      TSTORE(1)=0.                                                         01H1726
      TSTORE(2)=0.                                                         01H1727
      TSTORE(5)=0.                                                         01H1728
      GO TO 17                                                             01H1729
 16   L=1                                                                  01H1730
      IF(IM+1)  17.   18 . 17                                              01H1731
 17   CALL LOGS                                                            01H1732
      CALL GENPIS                                                          01H1733
C     ONLY RETURN STATEMENT ********************************************* 01H1734
      RETURN                                                               01H1735
 18   IM=1                                                                 01H1736
      GO TO 17                                                             01H1737
 20   CONTINUE                                                             01H1738
C     MODE 2 ASSIGNMENTS ************************************************01H1739
      ASSIGN 1002 TO IOUT1                                                 01H1740
      ASSIGN  16  TO IOUT2                                                 01H1741
C    IGO NOT ASSIGNED                                                      01H1742
      ASSIGN   16 TO IALTER                                                01H1743
      IF (XABSF(KA)+XABSF(KB-1)+XABSF(KC)+XABSF(KT-1)) 2170. 200. 2170     01H1744
 200  IF( IY) 202. 1004. 202                                               01H1745
 202  ASSIGN 0 TO IOUT1                                                    01H1746
      GO TO 1004                                                           01H1747
 22   CONTINUE                                                             01H1748
C     MODE 3 ASSIGNMENTS ************************************************01H1749
      ASSIGN 1016 TO IOUT1                                                 01H1750
      ASSIGN 1000 TO IOUT2                                                 01H1751
      ASSIGN   16 TO IGO                                                   01H1752
      ASSIGN 1010 TO IALTER                                                01H1753
      GO TO 1004                                                           01H1754
C     ENTER CONSTANT TEMPERATURE MODE  **********************************01H1755
 1000 KASAV=KA                                                             01H1756
      KBSAV=KB                                                             01H1757
      KCSAV=KC                                                             01H1758
      KTSAV=KT                                                             01H1759
      KA=0                                                                 01H1760
```

```
      KB=1                                                              01H1761
      KC=0                                                              01H1762
      K=1                                                               01H1763
      IMODSV=MODE                                                       01H1764
      MODE=2                                                            01H1765
      TSTOP=TEMP                                                        01H1766
      GO TO IGO ,(  1, 16 )                                             01H1767
C     LEAVE CONSTANT TEMPERATURE MODE   ********************************01H1768
 1002 KA=KASAV                                                          01H1769
      KB=KBSAV                                                          01H1770
      KC=KCSAV                                                          01H1771
      KT=KTSAV                                                          01H1772
      MODE=IMODSV                                                       01H1773
      GO TO 16                                                          01H1774
C     TEST FOR LIMITS  *************************************************01H1775
 1004 ER2=FLOATF(NA+NB+3)/20000.                                        01H1776
      ER1=0.                                                            01H1777
      N=NA+NB+2                                                         01H1778
      IF(KT-1) 2002, 2000, 2002                                         01H1779
 2000 N=N-1                                                             01H1780
 2002 DO 2004 I=1,N                                                     01H1781
 2004 ER1=ER1+  ABSF( ANS(I))                                           01H1782
      IF(ER1-ER2) 2006,1006,1006                                        01H1783
 2006 CALL SOLIDS(L2)                                                   01H1784
      IF(L2-1) 2008,2008,2010                                           01H1785
 2008 GO TO IOUT1,( 8, 1002, 1016)                                      01H1786
 2010 GO TO IOUT2 ,( 16, 1000)                                          01H1787
C     IOUT1  -NO SOLIDS ENTERED                                         01H1788
C     IOUT2  -NEW SOLIDS                                                01H1789
C     OTHERWISE GO TO CHANGE VARIABLE VALUES ***************************01H1790
 1006 N=NA+NB+2                                                         01H1791
C     COMPUTATION BLOCK-VARIABLE TEMPERATURE CONTROLS  *****************01H1792
      TTEST=EXPF(LOGF(TEMP)+ANS(N))                                     01H1793
      PMONE=ABSF(TTEST-TEMP)/(TTEST-TEMP)                               01H1794
C     IF PMONE IS POSITIVE-SYSTEM TEMPERATURE IS ASCENDING              01H1795
C              ... NEGATIVE ... DECENDING                               01H1796
      XA=LOGF(1.+ .1*PMONE)                                             01H1797
      XA2=LOGF(1.+.005 *PMONE)                                          01H1798
C     ALTER VARIABLES-EXCEPT FOR TEMPERATURE  **************************01H1799
      DO  2110   J=1,NA                                                 01H1800
      I1=IMAJOR(J)                                                      01H1801
```

```
      IF(ABSF(ANS(J))-ABSF(PLN(I1)))   2104, 2104, 2100                 01H1802
 2100 IF(ABSF(ANS(J))-5.)2104, 2104, 2102                               01H1803
 2102 ANS(J)=5.*ANS(J)/ABSF(ANS(J))                                     01H1804
 2104 PLN(I1)=PLN(I1)+ANS(J)                                            01H1805
      IF(PLN(I1)+40.) 2106, 2106, 2108                                  01H1806
 2106 PRESS(I1)=0.                                                      01H1807
      GO TO 2110                                                        01H1808
 2108 PRESS(I1)=EXPF(PLN(I1))                                           01H1809
 2110 CONTINUE                                                          01H1810
C     ELEMENTS AND PRODUCT GASSES TAKEN CARE OF, NOW FOR SOLIDS  *******01H1811
      IF(NB) 2131, 2131, 2112                                           01H1812
 2112 NSOL=NG                                                           01H1813
      DO  2130   I=1,NB                                                 01H1814
 2114 NSOL=NSOL+1                                                       01H1815
      IF(ITATE(NSOL)) 2114, 2114, 2116                                  01H1816
 2116 INDEX=NA+I                                                        01H1817
      B=ANS(INDEX)/PRESS(NSOL)                                          01H1818
      IF( B- 2. ) 2118 , 2124 ,2122                                     01H1819
 2118 IF( B+ 5. ) 2120, 2120 , 2124                                     01H1820
 2120 B=-5.                                                             01H1821
      GO TO 2124                                                        01H1822
 2122 B=2.                                                              01H1823
 2124 PLN(NSOL)=PLN(NSOL)+B                                             01H1824
      IF(PLN(NSOL)+ 35. ) 2126, 2126 , 2128                             01H1825
 2126 PRESS(NSOL)=0.                                                    01H1826
      PLN(NSOL)=0.                                                      01H1827
      NB=NB-1                                                           01H1828
      ITATE(NSOL)=-1*XABSF(ITATE(NSOL))                                 01H1829
      GO TO 2130                                                        01H1830
 2128 PRESS(NSOL)=EXPF(PLN  (NSOL))                                     01H1831
 2130 CONTINUE                                                          01H1832
 2131 J=NA+NB+1                                                         01H1833
      IF(ABSF(ANS(J))- 1. ) 2134 , 2134 , 2132                          01H1834
 2132 ANS(J)=ANS(J)/ABSF(ANS(J))                                        01H1835
 2134 BIGA=EXPF(LOGF(BIGA)+ANS(J))                                      01H1836
      GO TO IALTER,(16, 1010)                                           01H1837
C     TEMPERATURE CORRECTION  ***************************************01H1838
      DIMENSION TSTORE(10)                                              01H1839
 1010 N=NA+NB+2                                                         01H1840
      IF(MODE-1) 2140 , 2140 , 2150                                     01H1841
 2140 IF(ABSF(TTEST-TEMP)- 2. ) 2148,2148, 2142                         01H1842
```

```
 2142 IF(ABSF(XA)-ABSF(ANS(N))) 2144,2148, 2148                          01H1843
 2144 ANS(N)=XA
 2148 TEMP=EXPF(LOGF(TEMP)+ANS(N))                                       01H1847
      TTEST=TEMP                                                         01H1848
      CALL INTERP( TTEST,NONE,D)                                         01H1849
C     TEST HERE FOR MODE 1 ENTRANCE INTO MODE 3 ***********************01H1850
      IF (NONE) 12, 2149, 12                                             01H1851
 2149 IF(ABSF(TEMP-TSTOP)-.1*TSTOP) 16 , 16, 1000                        01H1852
C     MODE 3 NEVER USES THE EXACT ANS(N) THE VALUE IS LIMITED BY XA2 AND01H1853
C     ALWAYS LINEARLY INTERPOLATED  ************************************01H1854
 2150 IF(TSTORE(2))   2151, 2174, 2151                                   01H1855
 2151 IF( ABSF(TEMP-TTEST)-1.) 2176, 2176, 2152                          01H1856
C     TEST-BRACKETTING OF ANSWER  **************************************01H1857
 2152 IF(ANS(N)) 2154 , 2158 , 2156                                      01H1858
 2154 IF(TSTORE(2)) 2174 , 2158 ,2158
 2156 IF(TSTORE(2)) 2158 , 2158 ,2174
C     ANSWER BRACKETTED-INTERPOLATE LINEARLY ON LAST TWO ANSWERS  ******01H1862
 2158 GNU=ANS(N)/TSTORE(2)
      TEMP=(GNU*TSTORE(1)-TEMP)/(GNU-1.)
C     SET TO CONSTANT TEMPERATURE AGAIN . IGO HAS BEEN SET TO 16         01H1868
      GO TO 1000                                                         01H1869
C     ANSWER NOT BRACKETTED-CONTINUE USING XA2  ************************01H1870
 2174 TSTORE(2)=ANS(N)
      TSTORE(1)=TEMP
      TEMP=EXPF( LOGF(TEMP)+XA2)                                         01H1874
C    MODE 3 RELEASES IFAWAY FROM DISCONTINUITY                           01H1876
      T=TEMP+10.                                                         01H1877
      TT=TEMP-10.                                                        01H1878
      CALL INTERP(T,NONE,D)                                              01H1879
      CALL INTERP(TT,NTWO,D)                                             01H1880
      IF (NONE) 1000, 2175,1000                                          01H1881
 2175 IF (NTWO) 1000, 2170, 1000                                         01H1882
 1016 T=TEMP+10.                                                         01H1883
      TT=TEMP-10.                                                        01H1884
      CALL INTERP(T,NONE,D)                                              01H1885
      CALL INTERP(TT,NTWO,D)                                             01H1886
      IF (NONE)  8, 2168, 8                                              01H1887
 2168 IF (NTWO)  8, 2170, 8                                              01H1888
 2170 MODE=1                                                             01H1889
C     RELEASE FROM MODE 3 -THE ONLY PLACE IT CAN BE DONE  **************01H1890
      GO TO 16                                                           01H1891
```

```
2176 TEMP=(TEMP+TTEST)/2.                                          01H1896
     GO TO 16                                                      01H1897
     END
```

```
C       SUBROUTINE INTERP(TTEST,NONE,DELTA)                                    01H1327
        SUBROUTINE INTERP(TTEST,NONE,DELTA)                                    01H1328
C          ************** UPDATED 2/14/63                                      01H1329
        DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(       01H1330
       * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(        01H1331
       * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),       01H1332
       * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1333
       * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1334
       * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)               01H1335
        DIMENSION DJ(150),YJ(150)                                              01H1336
C       1/19/62                                                                01H1337
        COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H1338
       *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1339
       * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, Iw, IX, IY, IZ, ITA, ITB,01H1340
       * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,       01H1341
       * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,     01H1342
       * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,    01H1343
       * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H1344
       * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                    01H1345
       *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                            01H1346
        NB=NB                                                                  01H1347
        KB=KB                                                                  01H1348
        NONE=NONE                                                              01H1349
        DELTA=DELTA                                                            01H1350
        TTEST=TTEST                                                            01H1351
        IF(NB)2,2,8                                                            01H1352
 2      DELTA=1.                                                               01H1353
 4      NONE=0                                                                 01H1354
 6      RETURN                                                                 01H1355
 8      NGP1=NG+1                                                              01H1356
        DO 34 I=NGP1,ND                                                        01H1357
        IF(MASKPR(I)) 34,10,34                                                 01H1358
 10     IF(ITATE(I)) 34,34,12                                                  01H1359
 12     DO 30 J=1,19                                                           01H1360
        B=DATA(2,J+1,I)-DATA(2,J,I)-DATA(1,J,I)*(TARRAY(J+1)                   01H1361
       *-TARRAY(J))/1000.                                                      01H1362
        IF(ABSF(B)-1.5)30,30,14                                                01H1363
C                     NO DISC,DISC OK,BIG DISCONT                              01H1364
 14     IF(TEMP-TARRAY(J+1))  15,22,26                                         01H1365
 15     IF(TEMP-TARRAY(J))    27,27,16                                         01H1366
 16     IF(TTEST-TARRAY(J+1)) 28,28,17                                         01H1367
```

```
C16   SYSTEM TEMP IS WITHIN DISCONTINUITY ********************************01H1368
 17   TTEST=TARRAY(J+1)                                                    01H1369
C     SET TTEST TO UPPER BOUNDARY                                          01H1370
 18   NONE=-1                                                              01H1371
 19   DELTA=.0025                                                          01H1372
 20   RETURN                                                               01H1373
 22   IF(TTEST-TARRAY(J+1)) 23,30,30                                       01H1374
 23   NONE=1                                                               01H1375
      IF(KB)   19,25,24                                                    01H1376
 24   LE=LE-5                                                              01H1377
      GO TO 19                                                             01H1378
 25   LF=LF-5                                                              01H1379
      GO TO 19                                                             01H1380
 26   IF(TTEST-TARRAY(J+1)) 17,30,30                                       01H1381
 27   IF(TTEST-TARRAY(J))   30,30,29                                       01H1382
 28   IF(TTEST-TARRAY(J))   23,30,23                                       01H1383
 29   TTEST=TARRAY(J) +1.E-06                                              01H1384
      NONE=-1                                                              01H1385
      GO TO 19                                                             01H1386
 30   CONTINUE                                                             01H1387
 34   CONTINUE                                                             01H1388
      NONE=0                                                               01H1389
      DELTA=.0025                                                          01H1390
      RETURN                                                               01H1391
      END                                                                  01H1392
```

```
C      SUBROUTINE BUILD(L)      ROCKET PERFORMANCE VERSION                    01H1898
       SUBROUTINE BUILD(L)                                                    01H1899
       DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(       01H1900
      * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(        01H1901
      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),       01H1902
      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK      01H1903
      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),      01H1904
      * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)                01H1905
       DIMENSION DJ(150),YJ(150)                                              01H1906
C      1/19/62                                                                01H1907
       COMMON A, ABLOCK, ANS, BM, BIBLE,  GA, COEFS, CPHSDK, DATA, DATBU      01H1908
      *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,      01H1909
      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,      01H1910
      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,         01H1911
      * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,       01H1912
      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,      01H1913
      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY      01H1914
      * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                     01H1915
      *,GAMTH,PTHR,DAMI,DJ,YJ,YJA                                             01H1916
C  MATRIX  CONTROLS                                                           01H1917
C   TYPE  KA KB KC KT      COMMENTS              P H S HDP XA XT DELTA       01H1918
C                                                                            01H1919
C    1     0  1  0  1     CONST TEMP COMBUSTION   X          X     ERRORS    01H1920
C    2     0  1  0  0     VARIABLE TEMP COMB.    X X        X   X ERRORS    01H1921
C   3      1  1  0  0     ASSINED PRESS(ISENTROP) X   X      X   X ERRORS    01H1922
C    4     1  0  1  0     MACH ONE EXPANSION       X X      X   X ERRORS    01H1923
C    5     1  0  0 -1     ACOUSTIC VELOCITY          X      X     -XT       01H1924
C    6    -1  0  0 -1     SPECIFIC HEAT (CP)      X          X     -XT       01H1925
C    7     0 -1  0  0     CONST  DENSITY        RHO EROW           ERRORS    01H1926
C    8     1  0 -1  0     DETONATION            X      X    X   X SPECIA    01H1927
C                                                                            01H1928
       IPROW=0                                                              01H1929
       IHROW=0                                                              01H1930
       IHP=0                                                                01H1931
       ISROW=0                                                              01H1932
       IACOL=0                                                              01H1933
       ITCOL=0                                                              01H1934
       ICON=0                                                               01H1935
       DIMENSION HP(150),HDP(150),SP(150)                                   01H1936
       IF(KC)16,16,2                                                        01H1937
C2     COMPUTE HPRIMES*******************************************************01H1938
```

```
 2     DO 4 I=1,ND                                                          01H1939
 4     HP(I)=CPHSDK(2,I)*PRESS(I)                                           01H1940
       DO 14 I=1,ND                                                         01H1941
       IF(MASKPR(I))14,6,14                                                 01H1942
 6     IF(ITATE(I)-1)10,8,12                                                01H1943
 8     HDP(I)=HP(I)+1.98725*TEMP*PRESS(I)*DJ(I)/(2000.*DAM1)                01H1944
       GO TO 14                                                             01H1945
 10    HDP(I)=0.                                                            01H1946
       GO TO 14                                                             01H1947
 12    HDP(I)=HP(I)                                                         01H1948
 14    CONTINUE                                                             01H1949
 16    IF(KA)32,32,18                                                       01H1950
C18    COMPUTE SPRIMES*******************************************************01H1951
 18    DO 30 I=1,ND                                                         01H1952
       IF(MASKPR(I)) 28,20,28                                               01H1953
 20    IF(ITATE(I)-1)28,22,24                                               01H1954
 22    B=PRESS(I)*1.98725*(PLN(I)+1.)                                       01H1955
       GO TO 26                                                             01H1956
 24    B=0.                                                                 01H1957
 26    SP(I)=PRESS(I)*CPHSDK(3,I)-B                                         01H1958
       GO TO 30                                                             01H1959
 28    SP(I)=0.                                                             01H1960
 30    CONTINUE                                                             01H1961
 32    NC=NA+NB+1                                                           01H1962
C32    BEGIN TO SET ROW AND COLUMN CONTROLS *********************************01H1963
       IF(KB)36,36,34                                                       01H1964
C34    MATRIX HAS P ROW AND XA COL                                          01H1965
 34    IPROW=NC                                                             01H1966
       IACOL=IPROW                                                          01H1967
 36    IF(KA)54,48,38                                                       01H1968
C38    MATRIX HAS S ROW AND XA COLUMN****************************************01H1969
 38    IF(IPROW)42,42,40                                                    01H1970
C      IF PROW HAS BEEN SET, WE NEED XT COL**********************************01H1971
 40    ISROW=IPROW+1                                                        01H1972
       ITCOL=ISROW                                                          01H1973
C      AND ERROR COLUMN******************************************************01H1974
       ICON=ITCOL+1                                                         01H1975
       NC=ITCOL                                                             01H1976
       GO TO 56                                                             01H1977
C      PROW NOT SET                                                         01H1978
 42    ISROW=NC                                                             01H1979
```

```
      IACOL=ISROW                                                       01H1980
      IF(KC)46,46,44                                                    01H1981
C     IF KC=0, ACOUSTIC VELOCITY MATRIX   ***************************** 01H1982
 44   IHP=ISROW+1                                                       01H1983
      ITCOL=IHP                                                         01H1984
      ICON=IHP+1                                                        01H1985
      NC=IHP                                                            01H1986
C     MACH ONE MATRIX DONE***************************************************01H1987
      GO TO 56                                                          01H1988
 46   ITCOL=IACOL+1                                                     01H1989
      NC=IACOL                                                          01H1990
C     ACOUSTIC VELOCITY MATRIX DONE*****************************************01H1991
      GO TO 56                                                          01H1992
C48   GOT HERE FROM EFN 38 **************************************************01H1993
 48   IF(KT)50,50,52                                                    01H1994
 50   IHROW=IPROW+1                                                     01H1995
      ITCOL=IHROW                                                       01H1996
      NC=IHROW                                                          01H1997
      ICON=NC+1                                                         01H1998
C     COMBUSTION MARTRX DONE ************************************************01H1999
      GO TO 56                                                          01H2000
 52   NC=IPROW                                                          01H2001
      ICON=IPROW+1                                                      01H2002
C     COMBUSTION CONST TEMP MTX DONE  ***************************************01H2003
      GO TO 56                                                          01H2004
C54   SPECIFIC HEAT MATRIX- FROM EFN 36 *************************************01H2005
 54   IPROW=NC                                                          01H2006
      IACOL=IPROW                                                       01H2007
      ITCOL=IACOL+1                                                     01H2008
C     CP MATRIX DONE ********************************************************01H2009
 56   NCP1=NC+1                                                         01H2010
      NAP1=NA+1                                                         01H2011
      NGP1=NG+1                                                         01H2012
      NAP=NA+NB                                                         01H2013
      DO 58 I=1,NC                                                      01H2014
      DO 58 J=1,NCP1                                                    01H2015
 58   A(I,J)=0.                                                         01H2016
C     BEGIN ROW ENTRIES (J) FOR THE NA COL (I) ***************************01H2017
      DO 110 I=1,NA                                                     01H2018
      DO 64 J=1,ND                                                      01H2019
      WORK(J)=0.                                                        01H2020
```

```
      IF(MASKPR(J)) 64,60,64                                              01M2021
 60   DO 62 K=1,NA                                                        01M2022
 62   WORK(J)=WORK(J)+BIBLE(I,K)*COEFS(K,J)                               01M2023
 64   CONTINUE                                                            01M2024
      I2=IMAJOR(I)                                                        01M2025
C     MASS BALANCE ENTRIES*************************************************01M2026
      DO 70 J=1,NA                                                        01M2027
      DO 68 K=1,NG                                                        01M2028
      IF(MASKOR(K))68,66,68                                               01M2029
 66   A(J,I)=A(J,I)+COEFS(J,K)*WORK(K)*PRESS(K)                           01M2030
 68   CONTINUE                                                            01M2031
 70   A(J,I)=A(J,I)+COEFS(J,I2)*PRESS(I2)                                 01M2032
      IF(NB)78,78,72                                                      01M2033
 72   N=NA+1                                                              01M2034
      DO 76 J=NGP1,ND                                                     01M2035
      IF(ITATE(J))76,76,74                                                01M2036
 74   A(N,I)=WORK(J)                                                      01M2037
      A(I,N)=COEFS(I,J)                                                   01M2038
      N=N+1                                                               01M2039
 76   CONTINUE                                                            01M2040
C78   START OPTION TESTING*************************************************01M2041
 78   IF(IPROW)86,86,80                                                   01M2042
 80   DO 84 J=1,NG                                                        01M2043
      IF(MASKPR(J)) 84,81, 84                                             01M2044
 81   IF(MASKOR(J))84,82,84                                               01M2045
 82   A(IPROW,I)=A(IPROW,I)+PRESS(J)*WORK(J)                              01M2046
 84   CONTINUE                                                            01M2047
      A(IPROW,I)=A(IPROW,I)+PRESS(I2)                                     01M2048
 86   IF(IHROW)94,94,88                                                   01M2049
 88   DO 92 J=1,NG                                                        01M2050
      IF(MASKPR(J))  92, 90, 92                                           01M2051
 90   A(IHROW,I)=A(IHROW,I)+PRESS(J)*CPHSDK(2,J)*WORK(J)                  01M2052
 92   CONTINUE                                                            01M2053
 94   IF(ISROW)102,102,96                                                 01M2054
 96   DO 100 J=1,NG                                                       01M2055
      IF(MASKPR(J))  100, 98,100                                          01M2056
 98   A(ISROW,I)=A(ISROW,I)+SP(J)*WORK(J)                                 01M2057
100   CONTINUE                                                            01M2058
102   IF(IHP)110,110,104                                                  01M2059
104   DO 108 J=1,NG                                                       01M2060
      IF(MASKPR(J))  108,106,108                                          01M2061
```

```
 106  A(IHP,I)=A(IHP,I)+HDP(J)*WORK(J)                                  01H2062
 108  CONTINUE                                                          01H2063
C110  END OF FIRST NA COL                                               01H2064
 110  CONTINUE                                                          01H2065
      IF(NB) 500,500,122                                                01H2066
 122  IF(IHROW)132,132,124                                              01H2067
C     SOLID ENTRY FOR STATIC ENTHALPY COLUMN*****************************01H2068
 124  NAP1=NA+1                                                         01H2069
      N=NG+1                                                            01H2070
 126  IF(ITATE(N))128,128,130                                           01H2071
 128  N=N+1                                                             01H2072
      GO TO 126                                                         01H2073
 130  A(IHROW,NAP1)=CPHSDK(2,N)                                         01H2074
      N=N+1                                                             01H2075
      NAP1=NAP1+1                                                       01H2076
      IF(NAP1-NAP)126,126,132                                           01H2077
 132  IF(ISROW)142,142,134                                              01H2078
C     SOLID ENTRY FOR ENTROPY COLUMN*************************************01H2079
 134  NAP1=NA+1                                                         01H2080
      N=NG+1                                                            01H2081
 136  IF(ITATE(N))138,138,140                                           01H2082
 138  N=N+1                                                             01H2083
      GO TO 136                                                         01H2084
 140  A(ISROW,NAP1)=CPHSDK(3,N)                                         01H2085
      N=N+1                                                             01H2086
      NAP1=NAP1+1                                                       01H2087
      IF(NAP1-NAP)136,136,142                                           01H2088
 142  IF(IHP) 500,500,144                                               01H2089
C     SOLID ENTRY FOR TOTAL ENTHALPY COLUMN******************************01H2090
 144  NAP1=NA+1                                                         01H2091
      N=NG+1                                                            01H2092
 146  IF(ITATE(N))148,148,150                                           01H2093
 148  N=N+1                                                             01H2094
      GO TO 146                                                         01H2095
 150  A(IHP,NAP1)=CPHSDK(2,N)                                           01H2096
      NAP1=NAP1+1                                                       01H2097
      N=N+1                                                             01H2098
      IF(NAP1-NAP)146,146,500                                           01H2099
C     START XA COLUMN-ALWAYS DONE****************************************01H2100
 500  DO 504 J=1,NA                                                     01H2101
      DO 504 K=1,ND                                                     01H2102
```

```
      IF(MASKPR(K)) 504,502, 504                                        01H2103
  502 A(J,IACOL)=A(J,IACOL)-COEFS(J,K)*PRESS(K)                         01H2104
  504 CONTINUE                                                          01H2105
  152 IF(IHROW)160,160,154                                              01H2106
  154 DO 158 I=1,ND                                                     01H2107
      IF(MASKPR(I))158,156,158                                          01H2108
  156 A(IHROW,IACOL)=A(IHROW,IACOL)-PRESS(I)*CPHSDK(2,I)                01H2109
  158 CONTINUE                                                          01H2110
  160 IF(ISROW)172,172,162                                              01H2111
  162 DO 170 I=1,ND                                                     01H2112
      IF(MASKPR(I)) 170, 164,170                                        01H2113
  164 IF(ITATE(I)-1)170,166,168                                         01H2114
  166 A(ISROW,IACOL)=A(ISROW,IACOL)-SP(I)-1.98725*PRESS(I)              01H2115
      GO TO 170                                                         01H2116
  168 A(ISROW,IACOL)=A(ISROW,IACOL)-SP(I)                               01H2117
  170 CONTINUE                                                          01H2118
  172 IF(IHP)180,180,174                                                01H2119
  174 DO 178 I=1,ND                                                     01H2120
      IF(MASKPR(I))178,176,178                                          01H2121
  176 A(IHP,IACOL)=A(IHP,IACOL)-HDP(I)                                  01H2122
  178 CONTINUE                                                          01H2123
  180 IF(KT)182,182, 236                                                01H2124
  182 DO 186 I=1,NA                                                     01H2125
      DO 186 J=1,NG                                                     01H2126
      IF(MASKPR(J))186,184,186                                          01H2127
  184 A(I,ITCOL)=COEFS(I,J)*PRESS(J)*CPHSDK(4,J)+A(I,ITCOL)             01H2128
  186 CONTINUE                                                          01H2129
      IF(NB)196,196,188                                                 01H2130
  188 NAP1=NA+1                                                         01H2131
      NAP=NA+NB                                                         01H2132
      N=NG+1                                                            01H2133
  190 IF(ITATE(N))192,192,194                                           01H2134
  192 N=N+1                                                             01H2135
      GO TO 190                                                         01H2136
  194 A(NAP1,ITCOL)=CPHSDK(4,N)                                         01H2137
      NAP1=NAP1+1                                                       01H2138
      N=N+1                                                             01H2139
      IF(NAP1-NAP)190,190,196                                           01H2140
  196 IF(IPROW)204,204,198                                              01H2141
  198 DO 202 I=1,NG                                                     01H2142
      IF(MASKPR(I))202,200,202                                          01H2143
```

```
  200  A(IPROW,ITCOL)=A(IPROW,ITCOL)+PRESS(I)*CPHSDK(4,I)                    01H2144
  202  CONTINUE                                                              01H2145
  204  IF(IHROW)216,216,206                                                  01H2146
  206  S1=0.                                                                 01H2147
       S2=0.                                                                 01H2148
       DO 214 I=1,ND                                                         01H2149
       IF(MASKPR(I))214,208,214                                              01H2150
  208  IF(ITATE(I)-1)214,210,212                                             01H2151
  210  S1=S1+PRESS(I)*CPHSDK(4,I)*CPHSDK(2,I)                                01H2152
  212  S2=S2+PRESS(I)*CPHSDK(1,I)                                            01H2153
  214  CONTINUE                                                              01H2154
       A(IHROW,ITCOL)=S1+TEMP/1000.*S2                                       01H2155
  216  IF(ISROW)226,226,218                                                  01H2156
  218  S1=0.                                                                 01H2157
       S2=0.                                                                 01H2158
       DO 225 I=1,ND                                                         01H2159
       IF(MASKPR(I)) 225, 220, 225                                           01H2160
  220  IF(ITATE(I)-1) 225, 222, 224                                          01H2161
  222  S1=S1+CPHSDK(4,I)*SP(I)                                               01H2162
  224  S2=S2+PRESS(I)*CPHSDK(1,I)                                            01H2163
  225  CONTINUE                                                              01H2164
       A(ISROW,ITCOL)=S1+S2                                                  01H2165
  226  IF(IHP)236,236,228                                                    01H2166
  228  S1=0.                                                                 01H2167
       S2=0.                                                                 01H2168
       DO 234 I=1,ND                                                         01H2169
       IF(MASKPR(I)) 234, 230, 234                                           01H2170
  230  IF(ITATE(I)-1)234,232,233                                             01H2171
  232  S1=S1+HDP(I)*CPHSDK(4,I)                                              01H2172
  233  S2=S2+PRESS(I)*CPHSDK(1,I) +HDP(I)-HP(I)                              01H2173
  234  CONTINUE                                                              01H2174
       A(IHP,ITCOL)=S1+TEMP/1000.*S2                                         01H2175
  236  IF(ICON)238,238,242                                                   01H2176
  238  DO 240 I=1,NC                                                         01H2177
  240  A(I,ITCOL)=-A(I,ITCOL)                                                01H2178
       GO TO 276                                                             01H2179
  242  DO1245 I=1,NA                                                         01H2180
       IF( BM(I)        ) 243, 243, 2441                                     01H2181
  243  A(I,ICON)=A(I,IACOL)                                                  01H2182
       A(I,IACOL)=0.                                                         01H2183
C*************************************************************************01H2184
```

```
      GO TO1245                                                          01M2185
2441  ABC=(BIGA*BM(I))/(-A(I,IACOL))                                     01M2186
244   A(I,ICON)=-A(I,IACOL)*LOGF(ABC)                                    01M2190
1245  CONTINUE                                                           01M2191
      IF(NB)256,256,245                                                  01M2192
245   NAP1=NA+1                                                          01M2193
      N=NG+1                                                             01M2194
246   IF(ITATE(N))248,248,250                                            01M2195
248   N=N+1                                                              01M219E
      GO TO 246                                                          01M2197
250   DO 254 J=1,NA                                                      01M2198
      S1=0.                                                              01M2199
      DO 252 K=1,NA                                                      01M2200
252   S1=S1+BIBLE(J,K)*COEFS(K,N)                                        01M2201
      I1=IMAJOR(J)                                                       01M2202
254   A(NAP1,ICON)=A(NAP1,ICON)+S1*PLN(I1)                               01M2203
      A(NAP1,ICON)=-(CPHSDK(5,N)+A(NAP1,ICON))                           01M2204
      NAP1=NAP1+1                                                        01M2205
      IF(NAP1-NAP)248,248,256                                            01M2206
256   IF(IPROW)264,264,258                                               01M2207
258   DO 262 I=1,NG                                                      01M2208
      IF(MASKPR(I))262,260,262                                           01M2209
260   A(IPROW,ICON)=A(IPROW,ICON)+PRESS(I)                               01M2210
262   CONTINUE                                                           01M2211
      A(IPROW,ICON)=A(IPROW,ICON)*LOGF(PREF/A(IPROW,ICON))               01M2212
264   IF(IMROW)268,268,266                                               01M2213
266   A(IMROW,ICON)=-A(IMROW,IACOL)*LOGF(BIGA*HC/(-A(IMROW,IACOL)))      01M2214
268   IF(IHP)272,272,270                                                 01M2215
270   A(IHP,ICON)=-A(IHP,IACOL)*LOGF(BIGA*HC/(-A(IHP,IACOL)))            01M2216
272   IF(ISROW)276,276,274                                               01M2217
274   A(ISROW,ICON)=-A(ISROW,IACOL)*LOGF(BIGA*SC/(-A(ISROW,IACOL)))      01M2218
276   IF(IU) 277, 280, 277                                               01M2219
277   IF(IHP) 280,280,278                                                01M2220
278   WRITE OUTPUT TAPE I'O,282,((NAME (I,J),I=1,2),HP(J),HDP(J),SP(J),  01M2221
     *DJ(J),J=1,ND)                                                      01M2222
280   RETURN                                                             01M2223
282   FORMAT(  1H1,10X, 7HPRODUCT,10X, 2HHP,16X,3HHDP,15X,2HSP,16X,2HDJ/01M2227
     */(5X,2A6,4E16.8))                                                  01M2228
      END                                                                01M2229
```

```
C     SUBROUTINE GETMAJ                                                 01H1480
      SUBROUTINE GETMAJ(L)                                              01H1481
C     THIS GETMAJ IS SETUP FOR GAS SELECTION ONLY                       01H1482
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H1483
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H1484
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H1485
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1486
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1487
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H1488
C       11 / 15/ 61                                                     01H1489
      COMMON A, ABLOCK, ANS, EM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H1490
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1491
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H1492
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITJ, ITATE, IBREAK, IMAJOR,   01H1493
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H1494
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H1495
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H1496
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY               01H1497
C      IN ORDER TO EXIT PROPERLY, L MUST BE ZERO                        01H1498
      DO 2 I=1,ND                                                       01H1499
      MASKS(I)=0                                                        01H1500
 2    MOUT(I)=0                                                         01H1501
      LC=0                                                              01H1502
      NGP1=NG+1                                                         01H1503
      IF(IM) 14, 4 , 15                                                 01H1504
 4    DO 8 I=1,ND                                                       01H1505
      PRESS(I)=0.                                                       01H15002
      PLN(I)=0.                                                         01H15004
      MASKOR(I)=0                                                       01H1506
      IF(I-NGP1) 402,400,400
 400  ITATE(I)=-XABSF(ITATE(I))
 402  IF(I-NA)6,6,8                                                     01H1507
C     ALL PROPOSED SYSTEMS MUST HAVE AN ATOMIC SPECIES FOR              01H1508
C     EACH ATOMIC TYPE **************************************************01H1509
 6    IF (BM(I)-1.E-7)  5,  5, 7                                        01H1510
 5    PRESS(I)=FG(I)*PREF*.025                                          01H1511
      GO TO 9                                                           01H1512
 7    PRESS(I)=FG(I)*PREF*BM(I)*25.                                     01H1513
 9    PARRAY(I)=PRESS(I)                                                01H1514
      MASKOR(I)=I                                                       01H1515
      IMAJOR(I)=I                                                       01H1516
```

```
      PLN(I)=LOGF(PRESS(I))
    8 CONTINUE                                                          01M1517
      IM=-1                                                             01M1518
      DO 12 I=1,NA                                                      01M1519
      DO 10 J=1,NA                                                      01M1520
   10 BIBLE(I,J)=0.                                                     01M1521
   12 BIBLE(I,I)=1.                                                     01M1522
      CALL LOGS                                                         01M1523
      CALL GENPIS                                                       01M1524
   14 RETURN                                                            01M1525
   15 IF(IX)  16, 16, 307                                               01M1526
   16 IF(TEMP-1000.)14,14,17                                            01M1527
   17 DO 28 I=1,NA                                                      01M1528
C17   STARTS CHECKING FOR REAL MAJOR PRODUCTS ** BOX-A-**************** 01M1529
      A1=ABSF(PARRAY(I))                                                01M1530
      M1=IMAJOR(I)                                                      01M1531
      DO 26 J=1,NG                                                      01M1532
      IF(MASKPR(J))26,18,26                                             01M1533
   18 IF(MOUT(J))26,20,26                                               01M1534
   20 IF(COEFS(I,J))22,26,22                                            01M1535
   22 IF(A1-ABSF(PRESS(J))/PREF*COEFS(I,J)*BM(I)) 24, 24, 26            01M1536
   24 S=0.                                                              01M1537
      DO 124 K=1,NA                                                     01M1538
      IF(COEFS(K,J)) 123, 124, 123                                      01M1539
  123 S=S+1.                                                            01M1540
  124 CONTINUE                                                          01M1541
      IF(S-2.) 126, 126, 26                                             01M1542
  126 A1=ABSF(PRESS(J))                                                 01M1543
      M1=J                                                              01M1544
   26 CONTINUE                                                          01M1545
   28 MOUT(M1)=I                                                        01M1546
C    THE PRODUCTS WILL NOW BE MAGNITUDE ORDRED IN REVERSE               01M1547
      DO 280 I=1,NA                                                     01M1548
      I2=NA+1-I                                                         01M1549
      A2=ABSF(PARRAY(I2))                                               01M1550
      M1= IMAJOR(I2)                                                    01M1551
      DO 260 J=1,NG                                                     01M1552
      IF(MASKPR(J)) 260, 180, 260                                       01M1553
  180 IF(MASKS(J)) 260,200, 260                                         01M1554
  200 IF( COEFS(I2,J)) 220, 260, 220                                    01M1555
  220 IF(A2-ABSF(PRESS(J))/PREF*COEFS(I2,J)*BM(I2)) 240, 240, 260       01M1556
                                                                        01M1557
```

```
 240  S=0.                                                              01H1558
      DO 1244 K=1,NA                                                    01H1559
      IF(COEFS(K,J)) 1243, 1244, 1243                                   01H1560
 1243 S=S+1.                                                            01H1561
 1244 CONTINUE                                                          01H1562
      IF(S-?.) 1260, 1260, 260                                          01H1563
 1260 A2=ABSF(PRESS(J))                                                 01H1564
      M1=J                                                              01H1565
 260  CONTINUE                                                          01H1566
 280  MASKS(M1)=I2                                                      01H1567
      A1=0                                                              01H1568
      A2=0                                                              01H1569
      DO 330 I=1,NG                                                     01H1570
      IF(MOUT(I)) 300, 310, 300                                         01H1571
 300  A1=A1+PRESS(I)                                                    01H1572
 310  IF(MASKS(I)) 320, 330, 320                                        01H1573
 320  A2=A2+PRESS(I)                                                    01H1574
 330  CONTINUE                                                          01H1575
C  THE GREATER SUM WILL BECOME THE MOUT() ARRAY                        01H1576
      IF( A1-A2 ) 335, 350, 350                                         01H1577
 335  DO 340 I=1,NG                                                     01H1578
      MOUT(I)=MASKS(I)                                                  01H1579
 340  MASKS(I)=0                                                        01H1580
 350  REPL=0                                                            01H1581
C     CHECK FOR DIFFERENCES BETWEEN MOUT () AND MASKOR                 01H1582
      DO 36 I=1,NG                                                      01H1583
      IF(MASKPR(I))36,29,36                                             01H1584
 29   IF(MOUT(I))32,30,32                                               01H1585
 30   IF(MASKOR(I))34,36,34                                             01H1586
 32   IF(MASKOR(I))36,34,36                                             01H1587
 34   REPL=REPL+1.                                                      01H1588
 36   CONTINUE                                                          01H1589
      REPL=REPL/2.                                                      01H1590
C     TEST REPL FOR CHANGES TO THE PRODUCT ARRAY**********************01H1591
      IF(REPL)38,38,40                                                  01H1592
 38   L=0                                                               01H1593
 307  CALL JUGGLE(I)                                                    01H1594
      RETURN                                                            01H1595
C     BOX-B-**********************************************************01H1596
C     MOUT IS SET FOR A NON-ZERO ENTRY AT THE MAJORS                    01H1597
C     POSITION, IN ORDER TO REPLACE A REDUNDANT COEF SET                01H1598
```

```
C     THE POSITIONS ARE NOT ORDERED NUMERICALLY **********************01H1599
 40   I=1                                                             01H1600
      DO 50 J=1,NG                                                    01H1601
      IF(MASKPR(J))50,42,50                                           01H1602
 42   IF(MOUT(J))46,50,46                                             01H1603
 46   DO 48 K=1,NA                                                    01H1604
 48   A(I,K)=COEFS(K,J)                                               01H1605
      I=I+1                                                           01H1606
 50   CONTINUE                                                        01H1607
      IF(I-1-NA)52,54,52                                              01H1608
C     THE COEFICIENT MATRIX AND MASK MOUT ARE SET **********************01H1609
 52   L=6                                                             01H1610
      RETURN                                                          01H1611
 54   CALL LINCH(L1)                                                  01H1612
C     L1 WILL BE ZERO IF NO REDUNDANCY                                01H1613
      IF(L1)84,84,62                                                  01H1614
 62   LC=LC+1                                                         01H1615
C     START TO REPLACE REDUNDANT COEF SET                             01H1616
      IF(LC-50)66,64,64                                               01H1617
 64   L=5                                                             01H1618
      RETURN                                                          01H1619
 66   I=0                                                             01H1620
 68   I=I+1                                                           01H1621
      IF(MASKS(I))68,68,70                                            01H1622
 70   J=0                                                             01H1623
C     THE I-TH ROW IS REDUNDANT                                       01H1624
      DO 74 K=1,I                                                     01H1625
 72   J=J+1                                                           01H1626
      IF(MOUT(J))74,72,74                                             01H1627
 74   CONTINUE                                                        01H1628
C     THE JT-H PRODUCT IS THE REDUNDANT COEF SET **********************01H1629
      JJ=MOUT(J)                                                      01H1630
C     THE JJ-TH ELEMENT MAJOR MUST BE RECHOSEN **********************01H1631
      A1=0                                                            01H1632
      DO 82 K=1,NG                                                    01H1633
      IF(MASKPR(K))82,76,82                                           01H1634
 76   IF(MOUT(K))82,78,82                                             01H1635
 78   IF(COEFS(JJ,K))79 ,82, 79                                       01H1636
 79   IF(A1-ABSF(PRESS(K))) 80, 82, 82                                01H1637
 80   M1=K                                                            01H1638
      A1= ABSF(PRESS(K))                                              01H1639
```

```
 82   CONTINUE                                                          01H1640
      MOUT(M1)=JJ                                                       01H1641
      MOUT(J)=0                                                         01H1642
      GO TO 54                                                          01H1643
C84   NO REDUNDANCY IN THE MAJORS COEFFICIENTS **********************01H1644
C   AT THIS POINT , IT IS HOPED THAT MOUT()CONTAINS NON-ZERO ELEMENTS   01H1645
C  IN THE MAJOR PRODUCT POSITIONS,AND PARRAY() HAS MAJOR PRESSURES      01H1646
C   MOUT AND PARRAY ARE ORDERED     BY ELEMENTS AND NOT SEQUENCE        01H1647
 84   CALL INVRS(A,NA,TEST,DETER)                                       01H1648
      IF(TEST-1.) 83, 97, 83                                            01H1649
 83   DO 85 I=1,NG                                                     01H1650
 85   MASKOR(I)=0                                                       01H1651
  850 DO 92 I=1,NA                                                      01H1652
      DO 88 J=1,NG                                                      01H1653
      IF(MOUT(J)-I) 88, 86, 88                                          01H1654
 86   IMAJOR(I)=J                                                       01H1655
      PARRAY(I)=PRESS(J)                                                01H1656
      MASKOR(J)=1                                                       01H1657
      GO TO 90                                                          01H1658
 88   CONTINUE                                                          01H1659
 90   DO 92 K=1,NA                                                      01H1660
 92   A(I,K)=COEFS(K,J)                                                 01H1661
      DO 93 I=1,ND                                                      01H1662
 93    MOUT(I)=0                                                        01H1663
 94   CALL INVRS (A,NA,TEST,DETER)                                      01H1664
      DO 96 I=1,NA                                                      01H1665
      DO 96 J=1,NA                                                      01H1666
 96   BIBLE(I,J)=A(J,I)                                                 01H1667
 97   CALL LOGS                                                         01H1668
      CALL GENPIS                                                       01H1669
      CALL JUGGLE(L1)                                                   01H1670
C     WHEN L1 IS 1 ALL IS WELL *************************************** 01H1671
 98   IF(L1-1) 100, 99 , 100                                            01H1672
 99   L=2                                                               01H1673
      RETURN                                                            01H1674
100   CONTINUE                                                          01H1675
102   L=4                                                               01H1676
      RETURN                                                            01H1677
      END                                                               01H1678
```

```
C          SUBROUTINE  LINCH                                                    01H2397
      SUBROUTINE LINCH(L)                                                       01H2398
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H2399
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H2400
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H2401
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2402
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2403
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)           01H2404
C       11 / 15/ 61                                                         01H2405
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2406
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2407
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2408
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H2409
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2410
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2411
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2412
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                 01H2413
      L=0                                                                   01H2414
C     LINEAR DEPENDENCY CHECK                                               01H2415
      DO 2 I=1,ND                                                           01H2416
 2    MASKS(I)=0                                                            01H2417
      DO 24 I=1,NA                                                          01H2418
      MASKS(I)=I                                                            01H2419
      IP1=I+1                                                               01H2420
      LSAV=L                                                                01H2421
      DO 20 J=IP1,NA                                                        01H2422
      ACOMP=0.                                                              01H2423
      DO 18 K=1,NA                                                          01H2424
C     CHECK COLUMNS                                                         01H2425
      IF(A(I,K))8,6,8                                                       01H2426
    6 IF(A(J,K))20,18,20                                                    01H2427
    8 IF(A(J,K)) 10, 20, 10                                                 01H2428
 10   IF(ACOMP)14,12,14                                                     01H2429
 12   ACOMP=A(I,K)/A(J,K)                                                   01H2430
      GO TO 18                                                              01H2431
 14   A1=A(I,K)/A(J,K)                                                      01H2432
      IF( ABSF(A1-ACOMP)-1.E-10)  18 , 18 , 20                              01H2433
   18 CONTINUE                                                              01H2434
      L=L+1                                                                 01H2435
 20   CONTINUE                                                              01H2436
      IF ( LSAV-L) 24 , 22 , 22                                             01H2437
```

```
   22   MASKS(I)=0                                                    01H2438
   24   CONTINUE                                                      01H2439
        RETURN                                                        01H2440
        END                                                           01H2441
```

```
C         SUBROUTINE JUGGLE                                                    01H2345
      SUBROUTINE JUGGLE(L)                                                     01H2346
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H2347
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H2348
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H2349
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2350
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2351
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)           01H2352
C       11 / 15/ 61                                                          01H2353
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2354
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2355
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2356
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H2357
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2358
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2359
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2360
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H2361
      LB=0                                                                 01H2362
      ELAST=0.
      IF(NB)2,3,2                                                          01H2363
 2    L=1                                                                  01H2364
 8    RETURN                                                               01H2365
 3    E=0.                                                                 01H2366
 4    DO 6 I=1,30                                                          01H2367
 6    WORK(I)=0.                                                           01H2368
      DO 14 I=1,NA                                                         01H2369
      DO 12 J=1,ND                                                         01H2370
      IF(MASKPR(J))12,10,12                                                01H2371
 10   WORK(I)=WORK(I)+PRESS(J)*COEFS(I,J)                                  01H2372
 12   CONTINUE                                                             01H2373
      WORK (I)=LOGF(BM(I)*BIGA/WORK(I))                                    01H2374
 14   E=E+ABSF(WORK(I))                                                    01H2375
      IF(E-ELAST) 8,15,15
 15   IF(E-FLOATF(NA)*.7)2,2,16                                            01H2376
 16   LB=LB+1                                                              01H2377
      IF(LB-50)20,18,18                                                    01H2378
 18   L=2                                                                  01H2379
      GO TO 8                                                              01H2380
 20   DO 26 I=1,NA                                                         01H2381
      J=IMAJOR(I)                                                          01H2382
      G=0                                                                  01H2383
```

```
      DO 21 K=1,NA                                                    01H2384
21    G=G+WORK(K)*BIBLE(I,K)                                          01H2385
22    PLN(J)=PLN(J)+G /10.
      IF( PLN(J)+45.) 24, 24, 25
24    PRESS(J)=0.                                                     01H2388
      PARRAY(I)=0.                                                    01H2389
      GO TO 26                                                        01H2390
25    PRESS(J)=EXPF(PLN(J))                                           01H2391
      PARRAY(I)=PRESS(J)                                              01H2392
26    CONTINUE                                                        01H2393
      CALL GENPIS                                                     01H2394
      ELAST=E
      GO TO 3                                                         01H2395
      END                                                             01H2396
```

```
C       SUBROUTINE INVRS                                                  01H2442
        SUBROUTINE INVRS(A,N,TEST,DETER)                                  01H2443
C       INVERTS THE COEFICIENT AND PRODUCT MATRICES                       01H2444
        DIMENSION A(40,41),L(40),M(40)                                    01H2445
        N=N                                                               01H2446
        TEST=0.                                                           01H2447
  108   DETER=1.                                                          01H2448
        DO 180 K=1,N                                                      01H2449
        BIGA=A(K,K)                                                       01H2450
        DO 120 I=K,N                                                      01H2451
        DO 120 J=K,N                                                      01H2452
        IF(ABSF(BIGA)-ABSF(A(I,J)))110,110,120                            01H2453
  110   BIGA=A(I,J)                                                       01H2454
        L(K)=I                                                            01H2455
        M(K)=J                                                            01H2456
  120   CONTINUE                                                          01H2457
        JROW=L(K)                                                         01H2458
        IF(L(K)-K)135,135,125                                             01H2459
  125   DO 130 I=1,N                                                      01H2460
        HOLD=-A(K,I)                                                      01H2461
        A(K,I)=A(JROW,I)                                                  01H2462
  130   A(JROW,I)=HOLD                                                    01H2463
  135   ICOL=M(K)                                                         01H2464
        IF(M(K)-K)145,145,137                                             01H2465
  137   DO 140 J=1,N                                                      01H2466
        HOLD=-A(J,K)                                                      01H2467
        A(J,K)=A(J,ICOL)                                                  01H2468
  140   A(J,ICOL)=HOLD                                                    01H2469
  145   IF(A(K,K))147,143,147                                             01H2470
  143   TEST=1.                                                           01H2471
        GO TO 235                                                         01H2472
  147   DO 155 IC=1,N                                                     01H2473
        IF(IC-K)150,155,150                                               01H2474
  150   A(IC,K)=A(IC,K)/(-A(K,K))                                         01H2475
  155   CONTINUE                                                          01H2476
        DO 165 I=1,N                                                      01H2477
        DO 165 J=1,N                                                      01H2478
  156   IF(I-K)157,165,157                                                01H2479
  157   IF(J-K)160,165,160                                                01H2480
  160   A(I,J)=A(I,K)*A(K,J)+A(I,J)                                       01H2481
  165   CONTINUE                                                          01H2482
```

```
      DO 175 JR=1,N                                                    01M2483
  168 IF(JR-K)170,175,170                                              01M2484
  170 A(K,JR)=A(K,JR)/A(K,K)                                           01M2485
  175 CONTINUE                                                         01M2486
      DETER=DETER*A(K,K)                                               01M2487
      A(K,K)=1.0/A(K,K)                                                01M2488
  180 CONTINUE                                                         01M2489
      K=N                                                              01M2490
  200 K=K-1                                                            01M2491
      IF(K)235,235,203                                                 01M2492
  203 I=L(K)                                                           01M2493
      IF(I-K)220,220,205                                               01M2494
  205 DO 210 J=1,N                                                     01M2495
      HOLD=A(J,K)                                                      01M2496
      A(J,K)=-A(J,I)                                                   01M2497
  210 A(J,I)=HOLD                                                      01M2498
  220 J=M(K)                                                           01M2499
      IF(J-K)200,200,225                                               01M2500
  225 DO 230 I=1,N                                                     01M2501
      HOLD=A(K,I)                                                      01M2502
      A(K,I)=-A(J,I)                                                   01M2503
  230 A(J,I)=HOLD                                                      01M2504
      GO TO 200                                                        01M2505
  235 RETURN                                                           01M2506
      END                                                              01M2507
```

```
      SUBROUTINE GENPIS                                                 01H2508
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H2509
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H2510
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),   01H2511
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2512
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2513
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H2514
C       11 / 15/ 61                                                     01H2515
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2516
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2517
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2518
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H2519
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2520
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2521
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2522
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY               01H2523
C     BIBLE CONTAINS THE PROPER ARRAY. THIS ROUTINE ONLY GETS           01H2524
C     PARTIAL PRESSURES                                                 01H2525
       DO  3 I=1,NG                                                     01H2526
       PRESS(I )=0.                                                     01H2527
 1     IF(MASKOR(I)) 3,2,3                                              01H2528
 2     PLN(I)=0.                                                        01H2529
 3     CONTINUE                                                         01H2530
       DO 12 I=1,NG                                                     01H2531
       IF(MASKPR(I)) 12, 4, 12                                          01H2532
 4     IF(MASKOR(I)) 12, 5, 9                                           01H2533
C     MASKOR(I) CONTAINS THE MAJOR PRODUCT CODES ONLY                   01H2534
 5     DO 8 J=1,NA                                                      01H2535
       I2=IMAJOR(J)                                                     01H2536
       SUM=0.                                                           01H2537
       DO 6 K=1,NA                                                      01H2538
 6     SUM=SUM+COEFS(K,I)*BIBLE(J,K)                                    01H2539
 8     PLN(I)=PLN(I)+SUM*(PLN (I2))                                     01H2540
       PLN(I)=CPHSDK(5,I)+PLN(I)                                        01H2541
 9     IF(PLN(I)+35.)12,10,10                                           01H2542
 10    PRESS(I)=EXPF(PLN(I))                                            01H2543
 12    CONTINUE                                                         01H2544
       DO 14 I=1,NA                                                     01H2545
       I1=IMAJOR(I)                                                     01H2546
 14    PARRAY(I)=PRESS(I1)                                              01H2547
       DO 16 I=NG,ND                                                    01H2548
```

```
      IF(ITATE(I)) 15,15,16                                    01M2549
15    PRESS(I)=0.                                              01M2550
      PLN(I)=0.                                                01M2551
16    CONTINUE                                                 01M2552
      RETURN                                                   01M2553
      END                                                      01M2554
```

```
      SUBROUTINE ESCORT (E)                                                 01H2555
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(      01H2556
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(       01H2557
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),       01H2558
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2559
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2560
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)              01H2561
C       11 / 15/ 61                                                         01H2562
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2563
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2564
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2565
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    01H2566
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,   01H2567
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2568
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2569
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                  01H2570
      IF(E-100.) 10,2,10                                                  01H2571
 2    WRITE OUTPUT TAPE ITO,4                                             01H2572
 4    FORMAT( 67H1 ESCORT ENCOUNTERED IN CHAMBER,NO RESCUE POSSIBLE. PRO01H2573
     *BLEM BUMPED.)                                                       01H2574
 6    CALL DUMP2(E)                                                       01H2575
 8    CALL CHAIN(1,ITA)                                                   01H2576
 10   IF(E-200.)  16,12,16                                                01H2577
 12   WRITE OUTPUT TAPE ITO,14                                            01H2578
 14   FORMAT( 66H1 ESCORT ENCOUNTERED IN THROAT,NO RESCUE POSSIBLE. PROB01H2579
     *LEM BUMPED.)                                                        01H2580
      GO TO 8                                                             01H2581
 16   IF(NH) 22, 22,18                                                    01H2582
 18   WRITE OUTPUT TAPE ITO,20,NH                                         01H2583
 20   FORMAT( 67H1 ESCORT ENCOUNTERED IN EXPANSION ITERATION AT THE EXPA01H2584
     *NSION NUMBER I4,   32H.THIS PRESSURE WILL BE SKIPPED  /29H   AND TO01H2585
     *HE PROBLEM CONTINUED.)                                              01H2586
      TEMP=TEMP-100.                                                      01H2587
      RETURN                                                              01H2588
 22   WRITE OUTPUT TAPE ITO,24                                            01H2589
 24   FORMAT( 61H1 ESCORT ENCOUNTERED  REASON UNKNOWN. PROBLEM SYSTEM ST01H2590
     *OPPED.)                                                             01H2591
      GO TO 8                                                             01H2592
      END                                                                 01H259?
```

```
C                    SUBROUTINE LOGS                                        01H2594
      SUBROUTINE LOGS                                                       01H2595
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(      01H2596
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(      01H2597
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),      01H2598
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2599
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2600
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)           01H2601
C                                                                         01H2602
C       11 / 15/ 61                                                       01H2603
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2604
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,01H2605
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2606
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    01H2607
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2608
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,01H2609
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2610
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                 01H2611
      DIMENSION H(15),S(15)                                             01H2612
      R=1.98725                                                         01H2613
      IF(TEMP-TARRAY(20))4,4,2                                          01H2614
 2    L=0                                                               01H2615
      IG=1                                                              01H2616
      CALL SIFTIT(L)                                                    01H2617
                                                                        01H2618
      GO TO 6                                                           01H2619
 4    IF(TEMP-TARRAY(1))2,6,6                                           01H2620
 6    DO 10 I=2,20                                                      01H2621
      IF(TEMP-TARRAY(I))8,8,10                                          01H2622
 8    IM1=I-1                                                           01H2623
      GO TO 12                                                          01H2624
 10   CONTINUE                                                          01H2625
      IM1=19                                                            01H2626
      I=20                                                              01H2627
 12   I=IM1+1                                                           01H2628
      DO 20 J=1,ND                                                      01H2629
      CPHSDK(1,J)=DATA(1,IM1,J)+(TEMP-TARRAY(IM1))/                     01H2630
     *(TARRAY(I)-TARRAY(IM1))*(DATA(1,I,J)-DATA(1,IM1,J))               01H2631
      IF( ITATE(J)-1)  14,18,14                                         01H2632
 14   IF(DATA(2,I,J)-DATA(2,IM1,J)-(TARRAY(I)-TARRAY(IM1))*             01H2633
     *DATA(1,IM1,J)/1000.-1.5) 18,18,16                                 01H2634
 16   CPHSDK(2,J)=(DATA(2,I,J)-DATA(2,IM1,J))/(TARRAY(I)                01H2635
```

```
     *-TARRAY(IM1))*(TEMP-TARRAY(IM1))+DATA(2,IM1,J)                    01H2635
      CPHSDK(3,J)=(DATA(3,I,J)-DATA(3,IM1,J))/(TARRAY(I)-              01H2636
     *TARRAY(IM1))*(TEMP-TARRAY(IM1))+DATA(3,IM1,J)                    01H2637
      GO TO 20                                                         01H2638
18    CPHSDK(2,J)=DATA(2,IM1,J)+(DATA(1,IM1,J)+CPHSDK(1,J))            01H2639
     */2.*(TEMP-TARRAY(IM1))/1000.                                     01H2640
      CPHSDK(3,J)=DATA(3,IM1,J)+(DATA(1,IM1,J)+CPHSDK(1,J) )           01H2641
     */2.*(LOGF(TEMP)-LOGF(TARRAY(IM1)))                               01H2642
20    CONTINUE                                                         01H2643
                                                                       01H2644
                                                                       01H2645
22    DO 28 I=1,NA                                                     01H2646
      J=IMAJOR(I)                                                      01H2647
26    H(I)=CPHSDK(2,J)                                                 01H2648
28    S(I)=CPHSDK(3,J)                                                 01H2649
      DO 38 I=1,ND                                                     01H2650
      SUMH=0.                                                          01H2651
      SUMS=0.                                                          01H2652
      CPHSDK(4,I)=0.                                                   01H2653
      CPHSDK(5,I)=0.                                                   01H2654
      IF(MASKOR(I)) 38 , 30 , 38                                       01H2655
30    DO 36 J=1,NA                                                     01H2656
      SIG=0.                                                           01H2657
      DO 34 K=1,NA                                                     01H2658
      IF(COEFS(K,I))32,34,32                                           01H2659
32    SIG=SIG+COEFS(K,I)*BIBLE(J,K)                                    01H2660
34    CONTINUE                                                         01H2661
      SUMH=SUMH+SIG*H(J)                                               01H2662
36    SUMS=SUMS+SIG*S(J)                                               01H2663
      CPHSDK(4,I)=1000.*(CPHSDK(2,I)-SUMH)/(R*TEMP)                    01H2664
      SIGS=CPHSDK(3,I)-SUMS                                            01H2665
      IF(ABSF(SIGS)-1.E-3)35,35,37                                     01H2666
35    CPHSDK(5,I)=-1.E6                                                01H2667
      GO TO 38                                                         01H2668
37    CPHSDK(5,I)=SIGS/R-CPHSDK(4,I)                                   01H2669
38    CONTINUE                                                         01H2670
      RETURN                                                           01H2671
      END                                                              01H2672
```

```
C       SUBROUTINE SOLIDS
        SUBROUTINE SOLIDS(L)                                                    01H2673
        DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(        01H2674
       * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(         01H2675
       * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),        01H2676
       * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK      01H2677
       * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),      01H2678
       * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)                01H2679
C       11 / 15/ 61                                                             01H2680
        COMMON A, ABLOCK, ANS, BM, BIBLE, EIGA, COEFS, CPHSDK, DATA, DATBU      01H2681
       *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,       01H2682
       * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,      01H2683
       * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,         01H2684
       * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,       01H2685
       * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,      01H2686
       * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY      01H2687
       * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                     01H2688
        IIJ=NG+1                                                                01H2689
        ITEST1=0                                                                01H2690
        ITEST2=0                                                                01H2691
        SUM=0.                                                                  01H2692
        DO 14 I=IIJ,ND                                                          01H2693
        IF(ITATE(I)) 2,14,14                                                    01H2694
2       Y=CPHSDK(5,I)-.2                                                        01H2695
        DO 6 J=1,NA                                                             01H2696
        IMAJ=IMAJOR(J)                                                          01H2697
        B=0.                                                                    01H2698
        DO 4 K=1,NA                                                             01H2699
4       B=B+BIBLE(J,K)*COEFS(K,I)                                               01H2700
6       Y=Y+B*PLN(IMAJ)                                                         01H2701
        IF(Y)14,14,8                                                            01H2702
8       IF(SUM)10,10,12                                                         01H2703
10      SUM=Y                                                                   01H2704
        III=I                                                                   01H2705
        ITEST1=I                                                                01H2706
        GO TO 14                                                                01H2707
12      IF(SUM-Y)10,14,14                                                       01H2708
14      CONTINUE                                                                01H2709
        IF(ITEST1)24,24,16                                                      01H2710
16      DO 20 I=1,NA                                                            01H2711
        IF(COEFS(I,III))18,20,18                                                01H2712
                                                                                01H2713
```

```
 18   PRESS(III)=.01*BIGA*BM(I)/COEFS(I,III)                          01H2714
      PLN(III)=LOGF(PRESS(III))                                       01H2715
      ITATE(III)=XABSF(ITATE(III))                                    01H2716
      NB=NB+1                                                         01H2717
      GO TO 22                                                        01H2718
 20   CONTINUE                                                        01H2719
 22   L=2                                                             01H2720
      RETURN                                                          01H2721
 24   L=1                                                             01H2722
      RETURN                                                          01H2723
C     IF L=1-NO NEW SOLIDS,L=2-NEW SOLID                              01H2724
      END                                                             01H2725
```

```
      SUBROUTINE GETDJS(DJ,DAM1)                                        01H2726
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H2727
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H2728
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),   01H2729
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2730
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2731
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H2732
      DIMENSION DJ(150),YJ(150)                                         01H2733
C     1/19/62                                                           01H2734
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2735
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2736
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2737
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H2738
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2739
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2740
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2741
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H2742
     *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                        01H2743
      DO 2 I=1,ND                                                       01H2744
    2 DJ(I)=0.                                                          01H2745
      DO 4 I=1,NA                                                       01H2746
      II=IMAJOR(I)                                                      01H2747
    4 DJ(II)=ANS(I)                                                     01H2748
      DO 14 I=1,NG                                                      01H2749
      IF(MASKPR(I)) 14, 6, 14                                           01H2750
    6 IF(MASKOR(I)) 14, 8, 14                                           01H2751
    8 DO 12 J=1,NA                                                      01H2752
      SUM=0.                                                            01H2753
      II=IMAJOR(J)                                                      01H2754
      DO 10 K=1,NA                                                      01H2755
   10 SUM=SUM+COEFS(K,I)*BIBLE(J,K)                                     01H2756
   12 DJ(I)=DJ(I)+DJ(II)*SUM                                            01H2757
      DJ(I)=DJ(I)+CPHSDK(4,I)                                           01H2758
   14 CONTINUE                                                          01H2759
      IF(NB) 22,22,16                                                   01H2760
   16 N1=NA+1                                                           01H2761
      NAB=NA+NB                                                         01H2762
      NAP=NG                                                            01H2763
   18 NAP=NAP+1                                                         01H2764
      IF(ITATE(NAP)) 18,18,20                                           01H2765
   20 DJ(NAP)=ANS(N1)/PRESS(NAP)                                        01H2766
```

```
      N1=N1+1                                                          01H2767
      IF(N1-NAB) 18,18,22                                              01H2768
22    N=NA+NB+1                                                        01H2769
      DAM1=ANS(N)-1.                                                   01H2770
      RETURN                                                           01H2771
      END                                                              01H2772
```

```
      SUBROUTINE GETYJS                                                 01H2773
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H2774
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H2775
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H2776
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H2777
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H2778
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)          01H2779
      DIMENSION DJ(150),YJ(150)                                         01H2780
C     1/19/62                                                           01H2781
      COMMON A, ABLOCK, ANS, EM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H2782
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2783
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H2784
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H2785
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H2786
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2787
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H2788
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H2789
     *,GAMTH,PTHR,DAM1,DJ,YJ,YJA                                        01H2790
      CALL GETDJS(YJ,YJA)                                               01H2791
      YJA=YJA+1.                                                        01H2792
      RETURN                                                            01H2793
      END                                                               01H2794
```

```
      FUNCTION PARB(EPS,QRZ,ARG,NN)                                     01H2795
      DIMENSION EPS(600),QRZ(600)                                       01H2796
      IF(ARG-EPS(NN))206,230,2222                                       01H2797
  206 IF(ARG-EPS(NN-1))209,230,230                                      01H2798
  209 IF(ARG-EPS(3))211,211,217                                         01H2799
  211 T1=EPS(1)                                                         01H2800
      T2=EPS(2)                                                         01H2801
      T3=EPS(3)                                                         01H2802
      FT1=QRZ(1)                                                        01H2803
      FT2=QRZ(2)                                                        01H2804
      FT3=QRZ(3)                                                        01H2805
      GO TO 600                                                         01H2606
  217 DO 222 I=4,NN                                                     01H2807
      IF(ARG-EPS(I))227,225,222                                         01H2808
  222 CONTINUE                                                          01H2809
  227 EPT=(EPS(I-1)+EPS(I))/2.                                          01H2810
      IF(ARG-EPT)219,219,225                                            01H2811
  219 T1=EPS(I-2)                                                       01H2812
      T2=EPS(I-1)                                                       01H2813
      T3=EPS(I)                                                         01H2814
      FT1=QRZ(I-2)                                                      01H2815
      FT2=QRZ(I-1)                                                      01H2816
      FT3=QRZ(I)                                                        01H2817
      GO TO 600                                                         01H2818
  225 T1=EPS(I-1)                                                       01H2819
      T2=EPS(I)                                                         01H2820
      T3=EPS(I+1)                                                       01H2821
      FT1=QRZ(I-1)                                                      01H2822
      FT2=QRZ(I)                                                        01H2823
      FT3=QRZ(I+1)                                                      01H2824
  600 AY=(FT2-FT1)/(T2-T1)                                              01H2825
      BY=(FT3-FT2)/(T3-T2)                                              01H2826
      C=T3-T1                                                           01H2827
      D=(BY-AY)/C                                                       01H2828
      E=ARG-T2                                                          01H2829
      G=(D*E)+AY                                                        01H2830
      PARB=(ARG-T1)*G+FT1                                               01H2831
      GO TO 2223                                                        01H2832
  230 T1=EPS(NN-2)                                                      01H2833
      T2=EPS(NN-1)                                                      01H2834
      T3=EPS(NN)                                                        01H2835
```

```
      FT1=QRZ(NN-2)                                              01M2836
      FT2=QRZ(NN-1)                                              01M2837
      FT3=QRZ(NN)                                                01M2838
      GO TO 600                                                  01M2839
 2222 PARB=0.                                                    01M2840
 2223 RETURN                                                     01M2841
       END                                                       01M2842
```

```
      SUBROUTINE CHANGE(N1,N2)                                          01M1198
      N1=N2                                                             01M1199
      RETURN                                                            01M1200
      END                                                               01M1201
```

```
      SUBROUTINE CHANGE(N1,N2)                                          01H1198
      N1=N2                                                             01H1199
      RETURN                                                            01H1200
      END                                                               01H1201
```

```
C          SUBROUTINE SIFTIT                                                    01H1202
C         ************** UPDATED 2/14/63                                        01H1203
      SUBROUTINE SIFTIT(L)                                                     01H1204
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(         01H1205
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(         01H1206
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),         01H1207
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1208
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1209
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)                 01H1210
C       11 / 15/ 61                                                            01H1211
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBUC01H1212
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1213
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H1214
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,    01H1215
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H1216
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H1217
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H1218
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                      01H1219
C      8/28/61   H J VALE   THIS SUBROUTINE SEARCHES THE                     01H1220
C      DATA TAPE AND QUALIFIES PRODUCTS                                      01H1221
      DIMENSION COBU (50)                                                    01H1222
      N1TAPE=IN                                                              01H1223
      IF(IG)2,2,32                                                           01H1224
 2    IF(NA-15)4,4,28                                                        01H1225
C     NEW PROBLEM*************************************************************01H1226
C     NEL( ) IS LOADED,NA IS NO OF ELEMENTS ,AND                             01H1227
C     MASKEL IS SET TO MASK COEFICIENTS INTO COEFS                           01H1228
 4    REWIND ITE                                                             01H1229
      REWIND ITF                                                             01H1230
      IG=1                                                                   01H1231
      TEMP=3000.                                                             01H1232
      ND=1                                                                   01H1233
      ILO= 18                                                                01H1234
 6    READ TAPE ITD,ITATE(ND)                                                01H1235
      IF(ITATE(ND)-99)8,20,20                                                01H1236
 8    IF(ITATE(ND)-1) 9,9,7                                                  01H1237
 7    ITATE(ND)=-ITATE(ND)                                                   01H1238
 9    READ TAPE ITD,(NAME(I,ND),I=1,2),(COBU (I),I=1,                        01H1239
     *N1TAPE),(TBREAK(I,ND),I=1,3),(IBREAK(I,ND),I=1,3), H298,(              01H1240
     *(DATBU (I,J),I=1,4),J=1,65)                                           01H1241
      DO 12 I=1,N1TAPE                                                       01H1242
```

```
      IF(COBU (I))10,12,10                                                  01H1243
 10   IF(MASKEL(I))12,6,12                                                  01H1244
 12   CONTINUE                                                              01H1245
C PRODUCT HAS QUALIFIED-GO TO PUT IN DATA BLOCK. UPDATE ENTHALPIES FIRST   01H1246
      HBASE=0.                                                              01H1247
      DO 13 I=1,IN                                                          01H1248
 13   HBASE=HBASE+COBU(I)*HEL(I)                                            01H1249
      DO 15 I=1,65                                                          01H1250
 15   DATBU(3,I)=DATBU(3,I)+HBASE+H298                                      01H1251
C     ENTHALPIES   UPDATED TO MATCH THE TAPE BASE ARRAY   **************   01H1252
      K=1                                                                   01H1253
      DO 16 I=1,N1TAPE                                                      01H1254
      IF(MASKEL(I))14,16,14                                                 01H1255
 14   COEFS(K,ND)=COBU (I)                                                  01H1256
      K=K+1                                                                 01H1257
 16   CONTINUE                                                              01H1258
C     TRANSFER THE DATA BLOCK                                               01H1259
      DO 18 I=1,20                                                          01H1260
      DO 18 J=1,3                                                           01H1261
      K=ILO+I                                                               01H1262
 18   DATA(J,I,ND)=DATBU(J+1,K)                                             01H1263
      WRITE TAPE ITE,((DATBU (J,I),J=1,4),I=1,65)                           01H1264
      WRITE TAPE ITF, NAME(1,ND),NAME(2,ND),(COBU(I),I=1,N1TAPE),H298       01H1265
      WORK(ND)=H298                                                         01H1266
      ND=ND+1                                                               01H1267
      IF(ND-150)6,6,24                                                      01H1268
 20   WRITE TAPE ITE,ITATE(ND)                                              01H1269
      END FILE ITE                                                          01H1270
      END FILE ITF                                                          01H1271
      REWIND ITF                                                            01H1272
      ND=ND-1                                                               01H1273
 21   REWIND ITE                                                            01H1274
      REWIND ITD                                                            01H1275
      DO 22 I=1,20                                                          01H1276
      JJ=I+ILO                                                              01H1277
   22 TARRAY(I)=DATBU(1,JJ)                                                 01H1278
      NE=0                                                                  01H1279
      DO 23 I=1,ND                                                          01H1280
      IF(ITATE(I)-1)  25, 23, 25                                            01H1281
 25   NE=NE+1                                                               01H1282
 23   CONTINUE                                                              01H1283
```

```
      NG=ND-NE                                                          01H1284
      L=0                                                               01H1285
      RETURN                                                            01H1286
   24 REWIND ITE                                                        01H1287
      REWIND ITD                                                        01H1288
      WRITE OUTPUT TAPE 6,26                                            01H1289
   26 FORMAT(40H1  DATA STORAGE EXCEEDED PROBLEM DELETED)               01H1290
      CALL EXIT                                                         01H1291
   28 WRITE OUTPUT TAPE 6,30                                            01H1292
   30 FORMAT(40H1  ELEMENT STORAGE GREATER THAN PROVIDED)               01H1293
      CALL EXIT                                                         01H1294
   32 IF(TEMP-TARRAY(20))34,54,54                                       01H1295
   34 IF(TEMP-TARRAY(1))36,36,56                                        01H1296
   36 IF(TARRAY(1))38,38,40                                             01H1297
   38 L=1                                                               01H1298
      RETURN                                                            01H1299
   40 ILO=-10                                                           01H1300
      REWIND ITE                                                        01H1301
      READ TAPE ITE,((DATBU(I,J),I=1,4),J=1,65)                         01H1302
      REWIND ITE                                                        01H1303
      DO 42 I=1,65                                                      01H1304
      IF( TEMP- DATBU (1,I)) 43, 43 , 42                                01H1305
   42 ILO=ILO+1                                                         01H1306
   43 K=1                                                               01H1307
      IF(ILO)44,44,46                                                   01H1308
   44 ILO=0                                                             01H1309
      GO TO 50                                                          01H1310
   46 IF( ILO- 46)  50, 48, 48                                          01H1311
   48 ILO=45                                                            01H1312
   50 READ TAPE ITE,((DATBU (I,J),I=1,4),J=1,65)                        01H1313
      DO 52 I=1,20                                                      01H1314
      DO 52 J=1,3                                                       01H1315
      JJ=I+ILO                                                          01H1316
   52 DATA(J,I,K)=DATBU(J+1,JJ)                                         01H1317
      K=K+1                                                             01H1318
      IF(K-ND)50,50,21                                                  01H1319
   54 IF(TARRAY(20)-6000.)40,38,38                                      01H1320
   56 L=2                                                               01H1321
C          IF L=0  SUCCESSFUL RETURN, ALL O K                          01H1322
C          IF L=1   TEMP ARRAY UNCHANGABLE                             01H1323
C          IF L=2   INCORRECT TEMP SELECTION, ERROR RETURN             01H1324
```

```
      RETURN                                                    01M1325
      END                                                       01M1326
```

```
C       SUBROUTINE DUMP2(ENTRY)                                                 01H1393
      SUBROUTINE DUMP2(ENTRY)                                                   01H1394
C        ************** UPDATED 2/14/63                                         01H1395
      DIMENSION A(40,41), ANS(40), BIBLE(15,15) , COEFS(15,151), DATA(  01H1396
     * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(   01H1397
     * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),  01H1398
     * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK01H1399
     * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),01H1400
     * WORK(150), TITLE(18), IMAJOR(15),ABLOCK(10), KBLOCK(10)           01H1401
C       11 / 15/ 61                                                             01H1402
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU01H1403
     *,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H1404
     * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,01H1405
     * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,   01H1406
     * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,  01H1407
     * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H1408
     * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS,PREF,PLN,SC,TITLE, TARRAY01H1409
     * , TEMP, TBREAK, TAPID, WORK, MASKPR,KBLOCK ,PARRAY                01H1410
C      ENTRY IS PRINTED OUT TO TELL POSITION OF PROGRAM AT TIME OF DUMP  01H1411
C      IZ (IN COMMON) IS THE DUMP CONTROL VARIABLE                       01H1412
C      IZ=1   MATRIX,      IZ=2   BIBLE,      IZ=3   NEITHER,      IZ=4  01H1413
C      BOTH                                                              01H1414
C                                                                        01H1415
C                C.J.LEINTZ          10/18/61                            01H1416
C                                                                        01H1417
C      THE FOLLOWING IS ALWAYS PRINTED OUT                               01H1418
C                                                                        01H1419
      ENTRY=ENTRY                                                       01H1420
      WRITE OUTPUTTAPE(TO,100,ENTRY,IA,IB,IC,ID,IE,IF,IG,IH,IJ,IK,      01H1421
     1 IL,IM,IN,IO,IP,IQ,IR,IS,IT,IU,IV,IW,IX,IY,IZ,NA,NB,NC,ND,NE,NF,  01H1422
     2 NG,NH,NI,NJ,NK,LA,LB,LC,LD,LE,LF,LG,LH,LI,LJ,KA,KB,KC,KD,KE,KF   01H1423
  100 FORMAT(1H1,7H ENTRY=  F6.1,///5H  IA=I3,5H  IB=I3,5H  IC=I3,      01H1424
     15H  ID=I3,5H  IE=I3,5H  IF=I3,5H  IG=I3,5H  IH=I3,5H  IJ=I3,      01H1425
     25H  IK=I3,5H  IL=I3,5H  IM=I3,5H  IN=I3,/5H  IO=I3,5H  IP=I3,     01H1426
     35H  IQ=I3,5H  IR=I3,5H  IS=I3,5H  IT=I3,5H  IU=I3,5H  IV=I3,      01H1427
     45H  IW=I3,5H  IX=I3,5H  IY=I3,5H  IZ=I3,5H  NA=I3,/5H  NB=I3,     01H1428
     55H  NC=I3,5H  ND=I3,5H  NE=I3,5H  NF=I3,5H  NG=I3,5H  NH=I3,      01H1429
     65H  NI=I3,5H  NJ=I3,5H  NK=I3,5H  LA=I3,5H  LB=I3,5H  LC=I3,/     01H1430
     75H  LD=I3,5H  LE=I3,5H  LF=I3,5H  LG=I3,5H  LH=I3,5H  LI=I3,      01H1431
     85H  LJ=I3,5H  KA=I3,5H  KB=I3,5H  KC=I3,5H  KD=I3,5H  KE=I3,      01H1432
     95H  KF=I3,/)                                                      01H1433
```

```
      WRITE OUTPUTTAPE ITO,101,KG,KT,ITA,ITB,ITC,ITD,ITE,ITF,ITG,          01H1434
     1 ITH,ITI,ITO                                                         01H1435
  101 FORMAT(5H  KG=I3,5H  KT=I3,6H  ITA=I3,5H ITB=I3,                    01H1436
     15H ITC=I3,5H ITD=I3,5H ITE=I3,5H ITF=I3,5H ITG=I3,                   01H1437
     25H ITH=I3,5H ITI=I3,5H ITO=I3/)                                      01H1438
      WRITE OUTPUTTAPE ITO,102,PREF,BIGA,TEMP,HC,SC                        01H1439
  102 FORMAT(/7H  PREF=F9.4,5X5HBIGA=F11.5,5X5HTEMP=F11.5,                 01H1440
     15X3HHC=F11.5,5X3HSC=F11.5/)                                          01H1441
      WRITE OUTPUTTAPE ITO,103,NA,(IMAJOR(I),I=1,NA)                       01H1442
  103 FORMAT(/9H  IMAJOR(I3,1H),//(15I7))                                  01H1443
      WRITE OUTPUTTAPE ITO,104,NA,(PARRAY(I),I=1,NA)                       01H1444
  104 FORMAT(//9H  PARRAY(I3,1H),//(15F7.3))                               01H1445
      WRITE OUTPUTTAPE ITO,106                                             01H1446
  106 FORMAT(1H1,44X6HMASKPR,6H  MOUT/16X5HITATE,20X6HMASKOR,              01H1447
     112H  1  1 MASKS/16X1H1,29X9H1  1  1 1/7X4HNAME,5X1HV,                01H1448
     26X5HPRESS,9X3HPLN,6X1HV,2X1HV,2X1HV,2H V,3X2HCP,                     01H1449
     37X1HH,8X1HS,8X1HD,11X1HK)                                            01H1450
      DO 1 I=1,ND                                                          01H1451
    1 WRITE OUTPUTTAPE ITO,107,NAME(1,I),NAME(2,I),ITATE(I),PRESS(I),      01H1452
     1PLN(I),MASKOR(I),MASKPR(I),MOUT(I),MASKS(I),CPHSDK(1,I),            01H1453
     2CPHSDK(2,I),CPHSDK(3,I),CPHSDK(4,I),CPHSDK(5,I)                      01H1454
  107 FORMAT(3X2A6,I2,2PE14.6,0PE14.6,2I3,2I2,F7.3,F10.4,F8.3,F10.4,E14.01H1455
     16)                                                                   01H1456
      GO TO (20,30,40,20),IZ                                               01H1457
C                                                                          01H1458
C     IZ=1 OR 4, PRINTING OF MATRIX A(NC,NC+1) AND ANS(NC)                 01H1459
C                                                                          01H1460
   20 NC1=NC+1                                                             01H1461
      WRITE OUTPUTTAPE ITO,200,NC,NC1                                      01H1462
  200 FORMAT(1H1,2X9HMATRIX A(I3,1H,I3,1H)//)                              01H1463
      DO 21 I=1,NC                                                         01H1464
   21 WRITE OUTPUTTAPE ITO,201,I,(A(I,J),J=1,NC1)                          01H1465
  201 FORMAT(5H  ROWI3/(6E17.8))                                           01H1466
      WRITE OUTPUTTAPE ITO,202,NC,(ANS(I),I=1,NC)                          01H1467
  202 FORMAT(///2X4HANS(I3,1H)//(6E17.8))                                  01H1468
      GO TO (40,30,40,30),IZ                                               01H1469
C                                                                          01H1470
C     IZ=2 OR 4, PRINTING OF BIBLE(NA,NA)                                  01H1471
C                                                                          01H1472
   30 WRITE OUTPUTTAPE ITO,300,NA,NA                                       01H1473
  300 FORMAT(1H1,2X13HMATRIX BIBLE(I3,1H,I3,1H)//)                         01H1474
```

```
      DO 31 I=1,NA                                                      01H1475
31    WRITE OUTPUTTAPE10,301,I,(BIBLE(I,J),J=1,NA)                      01H1476
301   FORMAT(5H  ROW13/(6E17.8))                                        01H1477
40    RETURN                                                            01H1478
      END                                                               01H1479
```

```
C                    SUBROUTINE CROUT                                   01M2230
      SUBROUTINE CROUT ( A, ANS, NC, DETERM, NOERR)                     01M2231
C     SINGLE PRECISION MATRIX INVERSION AND                             01M2232
C        BACK SUBSTITUTION                                              01M2233
C     8/28/61  M J VALE                                                 01M2234
      DIMENSION A(40,41),M1(40),ANS(40),X(40)                           01M2235
      NOERR=0                                                           01M2236
      NOROW=NC                                                          01M2237
      NOCOL=NOROW+1                                                     01M2238
      DO 2 I=1,NOROW                                                    01M2239
    2 M1(I)=I                                                           01M2240
C     TEST FOR ROW AND COLUMN REARRANGEMENT                             01M2241
      DO 18 I=1,NOROW                                                   01M2242
      A1=ABSF(A(I,I))                                                   01M2243
      I1=I                                                              01M2244
      I2=I                                                              01M2245
      I3=I                                                              01M2246
      DO 6 J=I,NOROW                                                    01M2247
      DO 6 K=I,NOROW                                                    01M2248
      IF(ABSF(A(J,K))-A1)6,6,4                                          01M2249
    4 I2=J                                                              01M2250
      I3=K                                                              01M2251
      A1=ABSF(A(J,K))                                                   01M2252
    6 CONTINUE                                                          01M2253
      IF(I1-I2)8,12,12                                                  01M2254
    8 DO 10 J1=1,NOCOL                                                  01M2255
      Y=A(I1,J1)                                                        01M2256
      A(I1,J1)=A(I2,J1)                                                 01M2257
   10 A(I2,J1)=Y                                                        01M2258
   12 IF(I1-I3)14,18,18                                                 01M2259
   14 DO 16 J1=1,NOROW                                                  01M2260
      Y=A(J1,I1)                                                        01M2261
      A(J1,I1)=A(J1,I3)                                                 01M2262
   16 A(J1,I3)=Y                                                        01M2263
      M=M1(I1)                                                          01M2264
      M1(I1)=M1(I3)                                                     01M2265
      M1(I3)=M                                                          01M2266
   18 CONTINUE                                                          01M2267
      IF(A(1,1))22,20,22                                                01M2268
   20 NOERR=1                                                           01M2269
      DETERM=0.                                                         01M2270
```

```
      RETURN                                                              01H2271
 22   DO 24 I=2,NOCOL                                                     01H2272
 24   A(1,I)=A(1,I)/A(1,1)                                                01H2273
      DO 30 I=2,NOROW                                                     01H2274
      DO 30 J=2,NOCOL                                                     01H2275
      KK=XMINOF(I,J)                                                      01H2276
      KQ=KK-1                                                             01H2277
      SUM=0.                                                              01H2278
      DO 26 K=1,KQ                                                        01H2279
 26   SUM=-A(I,K)*A(K,J)+SUM                                              01H2280
      IF(ABSF(SUM+A(I,J))-1.E-7*ABSF(SUM)) 260,260,262                    01H2281
 260  A(I,J)=0.                                                           01H2282
      GO TO 27                                                            01H2283
 262  A(I,J)=SUM+A(I,J)                                                   01H2284
 27   D=1.                                                                01H2285
      IF(J-I)30,30,28                                                     01H2286
 28   D=A(KK,KK)                                                          01H2287
 30   A(I,J)=A(I,J)/D                                                     01H2288
      X(NOROW)=A(NOROW,NOCOL)                                             01H2289
      DO 320I=2,NOROW                                                     01H2290
      M=NOROW-I+1                                                         01H2291
      X(M)=A(M,NOCOL)*1.E+07                                              01H2292
      MP1=M+1                                                             01H2293
      DO 32 J=MP1,NOROW                                                   01H2294
 32   X(M)=X(M)-X(J)*A(M,J)*1.E+07                                        01H2295
 320  X(M)=X(M)/1.E+07                                                    01H2296
      N=1                                                                 01H2297
C     BACK SUBSTITUTE ANSWERS                                             01H2298
 34   IF(N-NOCOL)36,42,42                                                 01H2299
 36   J=0                                                                 01H2300
 38   J=J+1                                                               01H2301
      IF(N-M1(J))38,40,38                                                 01H2302
 40   ANS(N)=X(J)                                                         01H2303
      N=N+1                                                               01H2304
      GO TO 34                                                            01H2305
   42 DETERM=A(1,1)                                                       01H2306
C     OBTAIN AND TEST DETERMINATE                                         01H2307
      DO 44 I=1,NOROW                                                     01H2308
 44   DETERM=DETERM*A(I,I)                                                01H2309
      IF(ABSF(DETERM)-1.E-10)46,46,48                                     01H2310
 46   NOERR=2                                                             01H2311
```

```
   48   RETURN                                                    01M2312
        END                                                       01M2313
```

```
      SUBROUTINE PTABL(N,P1,PREF)                                       01H2314
      DIMENSION P(50)                                                   01H2315
      IF(N)4,2,4                                                        01H2316
      P(1)=1.                                                           01H2317
      P(2)=1.04                                                         01H2318
      P(3)=1.2                                                          01H2319
      P(4)=1.4                                                          01H2320
      P(5)=PREF/P1                                                      01H2321
      P(6)=3.4023                                                       01H2322
      P(7)=6.8046                                                       01H2323
      P(8)=10.2069                                                      01H2324
      P(9)=13.6091                                                      01H2325
      P(10)=17.0114                                                     01H2326
      P(11)=20.4137                                                     01H2327
      P(12)=34.0229                                                     01H2328
      P(13)=40.8275                                                     01H2329
      P(14)=47.6323                                                     01H2330
      P(15)=54.4366                                                     01H2331
      P(16)=68.0457                                                     01H2332
      P(17)=102.069                                                     01H2333
      P(18)=136.091                                                     01H2334
      P(19)=170.114                                                     01H2335
      P(20)=400.0                                                       01H2336
      P(21)=800.                                                        01H2337
      P(22)=1000.                                                       01H2338
      P(23)=1500.                                                       01H2339
      P(24)=2000.                                                       01H2340
      RETURN                                                            01H2341
    4 P1=P(N)                                                           01H2342
      RETURN                                                            01H2343
      END                                                               01H2344
```

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